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# AGRICULTURAL SCIENCES

## ОЦЕНКА ЗАСУХОУСТОЙЧИВОСТИ ПОКАЗАТЕЛЕЙ ВЕГЕТАЦИОННОГО ПЕРИОДА РИЛ ПОПУЛЯЦИИ ХЛОПЧАТНИКА

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## EVALUATION OF DROUGHT RESISTANCE OF INDICATORS OF THE VEGETATION PERIOD OF RIL COTTON POPULATION

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### АННОТАЦИЯ

В этой статье представлены результаты исследований по анализу устойчивости морфо-биологических и физиологических показателей фенотипов при водном стрессе в периоде вегетации популяции рекомбинантных инбредных линий (РИЛ), полученной в результате скрещивания гибридов сортов хлопчатника Наманган-77, который относится к средне волокнистым типам хлопка (*Gossypium hirsutum* L.) и Занги-Ота, который тоже относится к типу *G. hirsutum* L. но устойчивый в достаточной степени к водному дефициту по сравнению с сортом Наманган-77. Для определения устойчивости созданы искусственные режимы орошения двух видов – условно называемый оптимальный и сухой фон и в этих двух разных фоновых режимах выращены хлопчатники популяции РИЛ. Сравнительный анализ данных двух фоновых групп осуществлен посредством сопоставлений значений показателей фенотипов вегетационного периода этих групп с использованием программных процедур параметрической и непараметрической математической статистики таких, как разведочный анализ, *t*-критерий Стьюдента для независимых двух групп и *U* критерий Манна-Уитни пакета статистики SPSS 21. Полученные результаты показали на наличие статистически достоверного различия между основными показателями фенотипов исследованных групп, принадлежащих разным фоновым режимам орошения.

### ABSTRACT

This article presents the results of studies on the analysis of the stability of morpho-biological and physiological indicators of phenotypes under water stress during the growing season of a population of recombinant inbred lines (RIL), obtained by crossing hybrids of cotton varieties Namangan-77, which belongs to the medium fiber types of the cotton (*Gossypium hirsutum* L.) and the Zangi-Ota, which also belongs to the *G. hirsutum* L. type but is sufficiently resistant to water deficiency compared to the Namangan-77 variety. To determine the stability, artificial irrigation regimes of two types were created - conditionally called optimal and dry background, and in these two different background regimes cotton plants of the RIL population were grown. A comparative analysis of the data of two background groups was carried out by comparing the values of the indicators of the phenotypes of the growing season of these groups using the software procedures of parametric and non-parametric mathematical statistics, such as exploratory analysis, Student's *t*-test for independent two groups and the Mann-Whitney *U*

test of the SPSS 21 statistics package. The results obtained showed the presence of a statistically significant difference between the main indicators of the phenotypes of the studied groups belonging to different background irrigation regimes.

**Ключевые слова:** водный стресс, хлопчатник, вегетационный период, популяция РИЛ, критерий Манна-Уитни.

**Keywords:** water stress, cotton, growing season, RIL population, Mann-Whitney test.

#### Введение

В последние годы Узбекистан стал одним из лидеров по поставке хлопкового волокна в мировом масштабе, но устойчиво держится на достигнутом зависит кроме прочих, в основном и от обеспеченности хлопковых полей достаточном количестве водными ресурсами. Поскольку данная проблема имеет места и в других странах поставщиках хлопка-сырца, особенно если географическое расположение которых в южных и маловодных регионах, то для выхода из ситуации и сохранения неминуемой гибели урожая от засухи во всех странах ведутся исследования по созданию засухоустойчивых линий и сортов, основанные на методы от традиционной селекции до современной молекулярной биологии и генетики.

Узбекистан занял 25-е место из 164 в рейтинге стран, страдающих от водного стресса, опубликованном Институтом мировых ресурсов [1]. Гидроэнергетические ресурсы Узбекистана составляют всего 4,92% всей территории страны, общие водные ресурсы – 50–60 км<sup>3</sup> в год, из которых только 12,2 км<sup>3</sup> формируются на территории республики, а остальной объем воды поступает извне – с гор Тянь-Шаня и Памиро-Алтая, от тающих летом снегов и ледников [2]. Основная часть водных ресурсов идёт на орошение хлопковых полей. Население республики к 2030 г. по прогнозам возрастет почти до 40 млн. человек, что вызовет сокращение располагаемых водных ресурсов на 7-8 км<sup>3</sup>. В этих условиях дефицит водных ресурсов возрастет к 2030 г. с нынешних 13-14% до 44-46%, что может отрицательно влиять на развитие не только сельского хозяйства, но и других отраслей [3].

В статье [4] на примере Судана приводятся результаты исследований относительно водных проблем в сельском хозяйстве с учётом зарубежных изысканий в данном направлении и отмечается что, глобальное потепление и изменение климата также снижают урожайность. Ожидается, что засухи будут продолжать оказывать огромное давление на продовольственную безопасность в хрупких экосистемах. Чтобы выдержать эти стрессы, в различных исследованиях изучалась роль симбиотических микроорганизмов в фенотипической адаптации растений к стрессам окружающей среды [5, 6, 7, 8, 9]. По мнению авторов [10], грибковые эндифиты, которые являются важной составляющей растительного микробиома, могут играть ключевую роль в способности растений адаптироваться к климатическим стрессорам.

В работе [11] приводятся факты, связанные с водными проблемами растений, на которых отмечают, что у многих растений способность снижать потери воды в условиях дефицита влажности

является одним из основных критериев засухоустойчивости. Ряд учёных [12, 13, 14, 15] в своих исследованиях к таким критериям относили и тех признаков растений, какими являются увядание листьев, скорость потери воды срезанными листьями, относительное содержание воды для оценки засухоустойчивости. В своих работах Базел и его соавторы [14] указывали на то, что низкая потеря воды из иссеченного листа является простой, но относительно надёжный индикатор засухи устойчивости для пшеницы, хлопка и сорго. Также могут быть использованы в качестве физиологических критериев отбора для оценки засухоустойчивости относительное содержание воды в листьях (БСУХ), которое связано с уровнем водного статуса растения в конкретный момент времени.

На основе полученных результатов более поздних исследований по изучению влияния распределения осадков в течение сезона в своём коллективном труде [16] авторы выдвигают, среди прочих рядов предложений, и концепцию, заключающейся в том, что модель потребности сельскохозяйственных культур в воде, в том числе в течение сезона, должна заменить простую сезонную концепцию использования сельскохозяйственной воды.

Для решения вышеизложенных проблем относительно возделывания засухоустойчивых культур, в том числе и хлопчатника при водным стрессе, требуется разработки новых оригинальных инновационных агротехнических и селекционных методов с применением новейших достижений молекулярной биологии и генетики и других современных высокотехнологичных инженерных наук, внедрение которых в сельском хозяйстве уже во многих с развитой агрокультурой странах способствовало получению колоссальные экономические выгоды [17, 18].

Одной из последних открытий геномной инженерии – РНК-интерференция обеспечивала большие возможности для регуляции множество физиологических процессов в растениях посредством так называемые малые не кодирующие miРНК. Список воздействий, запускающих регуляторный ответ организма через miРНК, включает в себя реакцию на патогены, освещение, водный стресс, минеральное питание, солевой стресс, гипоксию, механический стресс и изменения температуры [19].

Закрепленные селекционерами в течении нескольких поколений полезные морфологические и физиологические признаки, в том числе и устойчивость к водным стрессам сортов могут изменяться под влиянием разных внешних климатических и других генетических факторов. Как отмечены в работах [20, 21], для предотвращения или минимизации таких явлений постоянно испытываются и внедряются различные методики генетики и селекции растений. К таким методикам можно отнести

принудительное самоопыление растений, отбор нежелательных особей, межсортовую гибридизацию и т.д., чтобы сорт состоялся, в основном из растений, однотипных по морфологическим признакам и хозяйственно-биологическим свойствам.

Однотипность растений и гомеостаз в популяционном уровне определяется постоянством способа опыления растений и уровнем модификационной изменчивости. В результате перекрестного опыления другими сортами и культурами в равной мере уменьшается однотипность сортов как перекрестноопыляющихся, так и самоопыляющихся культур [22, с. 298; 23, с. 63–65].

Опубликованном в исследовании [24] для изучения генетической основы засухоустойчивости сои (*Glycine max* L. Merr.) была создана рекомбинантная инбредная популяция из 184 линий F(2:7:11) от скрещивания двух засухоустойчивых сортов Kefeng1 и Nannong1138-2 и затем были протестированы в условиях водного стресса и при хорошем поливе в полевых условиях и в теплицах. Измеряемые признаки включали коэффициент увядания листьев, потерю воды срезанными листьями и относительное содержание воды в качестве индикаторов водного статуса растений и урожайности семян. По предположению авторов полученные результаты помогут выяснить генетическую основу засухоустойчивости сои и могут быть включены в программу селекции с использованием маркеров для создания высокоурожайных сортов сои с улучшенной устойчивостью к засухе.

Как известно, при инбридинге с каждым поколением возрастает количество гомозигот с частотой (согласно формулы Райта)  $F = 1 - (1/2)^n$ , где «n» - число инбредных поколений. Частота гетерозигот убывает с каждым поколением на  $1/2$  и соответствует  $(1/2)^n$ . За счет возрастания гомозиготности по рецессивным генам в инбредном потомстве наблюдается снижение жизнеспособности, продуктивности, т.е. наблюдается явление депрессии. Снижение продуктивности продолжается до 5-8 поколений в зависимости от вида растений, затем происходит стабильность [25].

В свете проведенного выше частичного анализа нынешнего состояния проблем водного стресса некоторых растений, нами было предпринято попытка провести сравнительный анализ РИЛ популяций хлопчатника, возделанной в Центре геномики и биоинформатики АН РУз в двух режимах орошения: искусственно созданном водном стрессе и при оптимальном поливе для оценки тех показателей фенотипов популяции, которые достоверно различаются и могут проявить себя как индикаторами засухоустойчивости в количественной мере.

**Цель исследования** Сравнительный анализ морфо-биологических, физиологических и агрономических признаков рекомбинантных инбредных линий хлопчатника (РИЛ), в оптимальном и засушливом режимах орошения посредством компьютерных программ статистического анализа параметрическим и непараметрическим методами.

#### **Методика исследования**

Объектом исследования являлись сорта хлопчатника Наманган-77, Занги-Ота и популяция рекомбинантных инбредных линий (РИЛ), полученная в результате скрещивания гибридов данных двух сортов. Сорт хлопчатника Наманган-77 относится к средне волокнистым типам хлопка (*Gossypium hirsutum* L.) и многие фермеры и хлопкоробы предпочитают этого сорта как элитный, отличающегося высокоурожайностью и с высоким выходом волокна. И поэтому в течении 30 лет возделывается данный сорт хлопчатника в обширных полях многих фермерских хозяйств Республики.

Из-за относительной неустойчивости данного сорта к водному дефициту, он выбран в качестве реципиента при создании популяции. Сорт Занги-Ота, который относится тоже к типу *G. hirsutum* L. и будучи среднеурожайным сортом, является как сортовым образцом гермоплазмы хлопчатника, в достаточной степени устойчивым к водному дефициту по сравнению с сортом Наманган-77.

Популяция РИЛ создана путем самоопыления методом “происхождения от общего предка” (SSD – single seed decent method) до поколения F7 каждого растения гибридного поколения F<sub>2</sub>, полученного в результате скрещивания сортов Наманган-77 и Занги-Ота, отличающихся различной устойчивостью к водному стрессу.

Данная популяция в условии водного дефицита состоит из 97 линий, обладающих широкими генетическими разнообразиями. Такие популяции являются важными генетическими материалами при определении локусов количественных признаков (QTL – quantitative traits loci), устойчивых к водному стрессу или генетической картировании.

Исследования проводилась в опытном поле Специального семеноводческого хозяйства при Центре геномики и биоинформатики АН РУз в оптимальном и искусственно созданном маловодном режимах орошении, так условно называемых в “оптимальном и сухом фонах”, согласно схемам (1 x 2 x 0) и (0 x 1 x 0). Все агротехнические процедуры относительно этим двум фонам проводились идентично. Общее количество воды в листьях растения определены по методу Н. Н. Третьякова [26], свойства удержания воды листьями - по методу М.Д. Кушниренко [27] и скорость транспирации – по методу А.А. Иванова [28].

Для достижения поставленной цели нами был использован комплекс программных систем SPSS 21, который состоит из программных процедур, реализующих многих методов анализа данных в современных компьютерах. Программный комплекс SPSS 21 имеет в научной практике широко распространенную программных процедур, которые по параметрическому методу математической статистики рассчитывает значения *t*-критерия Стьюдента, определяющего степень различия между двумя переменными *x* и *y*, предложенным Гассетом (Стьюдентом) и по непараметрическому методу с использованием *U* критерия Манн-Уитни и *W* теста

Уилкоксона решает ту же задачу на основе ранговых методов [29 30, 31, 32].

Ниже перечислены исследованные показатели, значения которых измерены с каждого отдельного куста хлопчатника РИЛ популяций по оптимальному и сухому фону.

- *Trnspir1h* - транспирация через один час
- *Trnspir2h* - транспирация через два часа
- *Trnspir4h* - транспирация через четыре часа
- *Water* - вода удерживаемость листьев
- *TwaterPlant* - общей процент воды, содержащихся в листьях
- *BCYX2h* - свойства удержания воды листьями за два часа
- *BCYX4h* - свойства удержания воды листьями за четыре часа
- *Hlorophil* - содержание хлорофилла
- *Height* - высота растения
- *hs* - высоты закладки первой плодовой ветви
- *Monop* - моноподиальные ветви хлопчатника
- *Simp* - симподиальные ветви хлопчатника
- *TBools* - общие количество коробочек
- *Bools* - количество раскрытых коробочек хлопчатника.

#### Результаты и обсуждение

В таблице 1 представлены средние и стандартные отклонения по каждому показателю линии сортов, соответствующих оптимальному и сухому режиму орошения. Кроме того, в конечных двух строках таблицы содержатся результаты тестирования исследуемых двух фоновых групп по *t*-критерию Стьюдента.

Сравнительный анализ средних показателей фенотипов линий хлопчатника оптимального и сухого режимов орошения показал, что только несколько одноимённые показатели заметно отличались количественно друг от друга, а у многих показателей различие средних значений между фонами оказалось незначительным. Среди сравниваемых показателей фонов, показатель *Water* имел наибольшую разность средних, равную 392,66. Следующие за ней показатели транспирации через четырёх *Trnspir4h* и двух *Trnspir2h* часов, длина растения *Height*, содержание хлорофилла *Hlorophil* и показатель транспирации через одного часа *Trnspir1h* имели разности средних, равные соответственно 92,72; 57,28; 37,34; -9,33 и -7,14, а разности средних между остальными показателями сравниваемых фонов были небольшими. Стандартные отклонения вышперечисленных показателей по сравнению фонов распределены попарно как 223,55 и 211,77; 74,31 и 94,35; 64,74 и 82,42; 13,06 и 7,82; 3,60 и 1,98; 28,68 и 43,62.

При сравнительной оценке средних значений показателей фенотипов сортов РИЛ хлопчатника средние значения стандартизованы посредством деления каждого среднего на его стандартного отклонения, и тем самым произведена нормировка для наглядного сопоставления данных двух режимов орошения в безразмерной величине. Результаты выполненных процедур отражены на сравнительных гистограммах нормированных средних показателей фенотипов оптимального и сухого фонов и показаны на рисунке 1.

Таблица 1

Описательная статистика и сравнение по *t*-Критерию средних сухого и оптимального фона

Признаки	Оптималь. фон		Сухой фон		<i>t</i> -Крит.	Знч.
	Средн.	Стд.от	Средн.	Стд.от		
<b>Trnspir1h</b>	117,38	28,68	124,52	43,62	1,82	0,179
<b>Trnspir2h</b>	242,42	64,75	185,14	82,42	28,97	0,0001
<b>Trnspir4h</b>	341,54	74,31	248,82	94,35	57,81	0,0001
<b>Water</b>	1215,18	223,55	822,52	211,77	157,72	0,0001
<b>TwaterPlant</b>	74,7	1,16	71,22	1,93	230,71	0,0001
<b>BCYX2h</b>	19,78	3,31	21,87	5,88	9,35	0,003
<b>BCYX4h</b>	28,12	3,51	29,76	6,11	5,3	0,022
<b>Hlorophil</b>	41,97	3,6	51,3	1,98	500,81	0,0001
<b>Height</b>	107,21	13,06	69,87	7,82	583,35	0,0001
<b>hs</b>	5,85	0,58	6,54	0,71	54,98	0,0001
<b>Monop</b>	1,33	0,61	1,32	0,62	0,01	0,907
<b>Simp</b>	17,39	1,72	12,74	1,41	423,2	0,0001
<b>TBools</b>	20,98	4,71	14,18	3,97	118,37	0,0001
<b>Bools</b>	7,25	4,32	7,81	3,42	1,03	0,312

Для установления различия оптимального и сухого фона по *t*-критерию Стьюдента, согласно категории, сравнение средних двух независимых групп, рассчитаны программой SPSS значения статистики и уровни значимости *t*-критерия, которые расположены на самых нижних двух строках таблицы 1. Самых высоких значений статистики *t*-критерия с очень высокими уровнями значимостей имели показатели фенотипов вегетационного периода: высота растения *Height*, ( $t = 583,35$ ;  $P <$

$0,0001$ ), степень содержания хлорофилла *Hlorophil* ( $t = 500,81$ ;  $P < 0,0001$ ), симподиальные ветви хлопчатника *Simp* ( $t = 423,20$ ;  $P < 0,0001$ ), общей процент воды, содержащиеся в листьях хлопчатника *TwaterPlant* ( $t = 230,71$ ;  $P < 0,0001$ ), количество общих коробочек хлопчатника *TBools* ( $t = 118,37$ ;  $P < 0,0001$ ) и показатель вода удерживаемости листьев хлопчатника *Water* ( $t = 157,72$ ;  $P < 0,0001$ ). Среди остальных, имевших самого низкого значения ста-

тики критерия и одновременно оказавшихся недостоверными, считались показатели фенотипов: моноподиальные ветви *Monop* ( $t = 0,01$ ;  $P < 0,907$ ), количество раскрытых коробочек *Bools* ( $t = 1,03$ ;  $P < 0,312$ ), и показатель транспирации через одного часа *Trnspir1h* ( $t = 1,82$ ;  $P < 0,179$ ). Кроме этих трёх статистически недостоверных показателей, все остальные одиннадцать показателей способствовали установлению статистически достоверного разли-

чия между двумя исследуемыми группами, представляющими оптимального и сухого фонового режима орошения и тем самым из-за значительно высокого значения уровней значимостей у многих показателей (в двух случаях  $P < 0,022$ ;  $P < 0,003$  и  $P < 0,0001$  – в остальных) отвергается нулевая гипотеза о равенстве средних и принимается альтернативная гипотеза о том, что между сравниваемыми группами существует статистически достоверное различие.

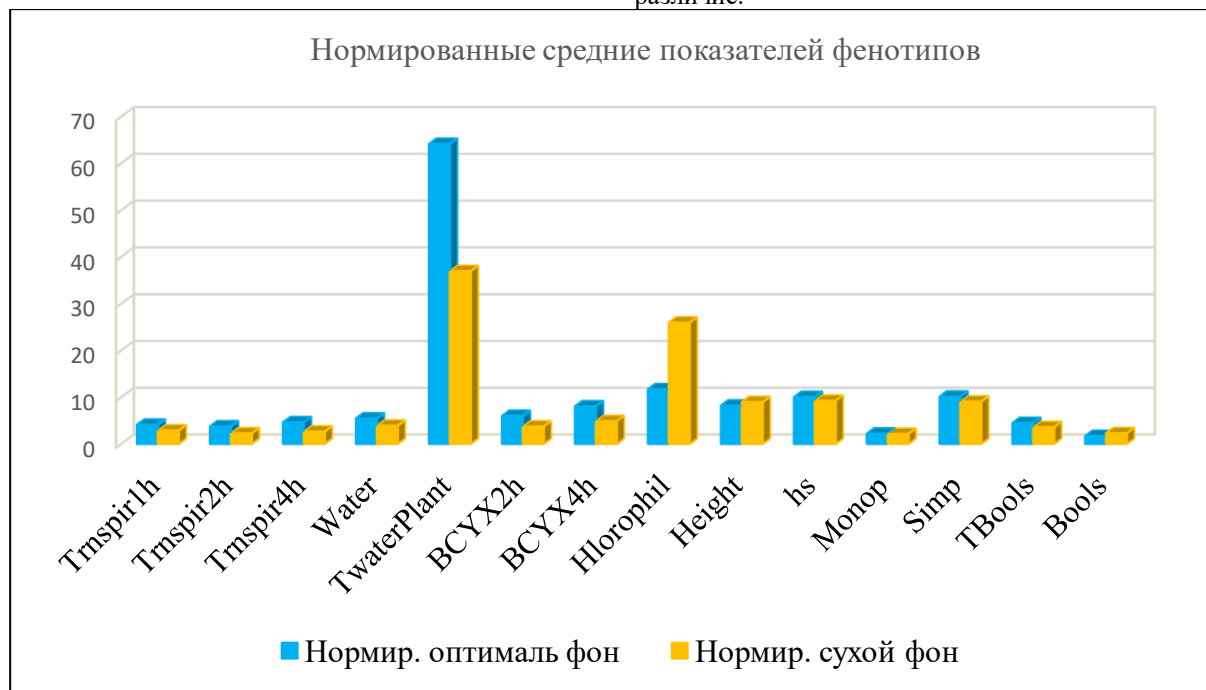


Рис. 1. Гистограммы нормированных средних показателей фенотипов оптимального и сухого фонов

Поскольку некоторые показатели (*Trnspir1h*, *Monop* и *Bools*) в результате тестирования наших данных посредством разведочного анализа по критерию Колмогорова-Смирнова, который проведен с целью проверки соответствия закона распределения показателей нормальному закону, не соответствовали необходимым условиям применения критерия Стьюдента для сравнения двух несвязанных выборок, было решено использовать и методы непараметрической статистики, для которых не играют роли законы распределения значения показателей и их параметры, а осуществляют ранжирование абсолютных значений признака, что позволяет сглаживать эффекты выбросов и асимметрии распределения.

Среди непараметрических критериев больше всего подходит  $U$  критерий Манна-Уитни при необходимости сравнения двух независимых групп, когда объём и распределения данных не соответствуют требованиям применения параметрического  $t$ -критерия.

При использовании  $U$  критерия Манна-Уитни для наших данных, учтены особенности его применения, заключающиеся в том, что тип анализируемых данных должен быть количественный или порядковый, выборки должны быть независимыми и закон распределения данных не обязательно нормальный.

В основу расчета  $U$  критерия Манна-Уитни заложен следующий алгоритм [32]:

1. Значения переменных обеих групп объединяются в единый вариационный ряд и ранжируются в порядке возрастания или убывания.

2. Абсолютные значения переменных заменяются рангами. В случае, если несколько значений равны

между собой, им присваивается средний ранг из тех, которые они получили бы, если бы не были равны.

3. Сумма рангов подсчитывается отдельно для каждой группы.

4. Значение критерия  $U$  Манна-Уитни рассчитывается по формуле:  $U = n1 \times n2 + (nх \times (nх + 1)) / 2 - Tх$

где  $n1$  и  $n2$  – количество наблюдений в сравниваемых группах,  $nх$  – количество наблюдений в группе, имеющее большую из двух ранговых сумм,  $Tх$  – большая из двух ранговых сумм.

5. По специальным таблицам, представленным в руководствах по статистике [33, 34], определяется критическое значение  $U$  для заданных значений  $n1$  и  $n2$  и критического уровня  $p$ . Если рассчитанное значение  $U$  меньше или равно критическому, то нулевая статистическая гипотеза отвергается и принимается альтернативная гипотеза, свидетельствующая о существовании различий между группами.

На начальном этапе программа  $U$  критерия Манна-Уитни реализует 1-3 пункта данного алгоритма выдаёт результаты предварительных расчётов, представленных в таблице 2. В этой таблице

расположены вычисленные программой средние и суммы рангов значений всех показателей фенотипов РИЛ популяций оптимального и сухого фонов.

Таблица 2

Ранг Фон	Средний ранг		Сумма рангов	
	Оптималь.	Сухой.	Оптималь	Сухой
<i>Trnspir1h</i>	91,4	103,6	8867	10048
<i>Trnspir2h</i>	120,4	74,6	11675,5	7239,5
<i>Trnspir4h</i>	126	69	12219,5	6695,5
<i>Water</i>	135,6	59,4	13156	5759
<i>TwaterPlant</i>	141,7	53,3	13742,5	5172,5
<i>BCYX2h</i>	85,3	109,7	8273,5	10641,5
<i>BCYX4h</i>	89,6	105,4	8693,5	10221,5
<i>Hlorophil</i>	51,1	143,9	4953	13962
<i>Height</i>	145,7	49,3	14136	4779
<i>hs</i>	73,6	121,4	7136	11779
<i>Monop</i>	97,8	97,2	9488,5	9426,5
<i>Simp</i>	143,8	51,2	13947	4968
<i>TBools</i>	133,2	61,8	12924	5991
<i>Bools</i>	90,8	104,2	8810	10105

В результате работы программы анализа по  $U$  критерию Манна-Уитни на следующем этапе получены значения статистик для данного критерия, наименьшее значение из обоих ранговых сумм критерия  $W$  Уилкоксона и тестовую величину  $Z$ , определенную по критерию Колмогорова-Смирнова, а также относящуюся к ней вероятность ошибки  $p$ , которую следует использовать при количестве наблюдений более 30 для всех показателей РИЛ популяций, и которые представлены в таблице 3.

Также, как и в случае применения параметрического метода, здесь тоже недостоверными оказались только три показателя фенотипов: моноидальные ветви *Monop* ( $U = 4057,000$ ;  $P < 0,928$ ), количество раскрытых коробочек *Bools* ( $U =$

$4057,000$ ;  $P < 0,097$ ) и показатель транспирации через один час *Trnspir1h* ( $U = 4114,000$ ;  $P < 0,131$ ). А по всем остальным показателям различие между группами, соответствующими оптимальному и сухому фону, по тесту  $U$  критерия Манна-Уитни получилось статистически достоверным, что количественно подтверждено значительно высокими уровнями значимостей показателей, равных в двух случаях  $P < 0,020$ ;  $P < 0,051$  и  $P < 0,0001$  – в остальных. И на данном обстоятельстве, как в случае  $t$ -критерия, отвергается нулевая гипотеза о равенстве средних и принимается альтернативная гипотеза о том, что сравниваемые группы существенно различаются с достаточно высокой статистической достоверностью.

Таблица 3

Признаки	Статистики критерия			
	$U$ Манна-Уитни	$W$ Уилкоксона	$Z$	Знч.
<i>Trnspir1h</i>	4114	8867	-1,51	0,131
<i>Trnspir2h</i>	2486,5	7239,5	-5,672	0,0001
<i>Trnspir4h</i>	1942,5	6695,5	-7,064	0,0001
<i>Water</i>	1006	5759	-9,459	0,0001
<i>TwaterPlant</i>	419,5	5172,5	-10,959	0,0001
<i>BCYX2h</i>	3520,5	8273,5	-3,028	0,002
<i>BCYX4h</i>	3940,5	8693,5	-1,954	0,051
<i>Hlorophil</i>	200	4953	-11,52	0,0001
<i>Height</i>	26	4779	-11,968	0,0001
<i>hs</i>	2383	7136	-6,59	0,0001
<i>Monop</i>	4673,5	9426,5	-0,091	0,928
<i>Simp</i>	215	4968	-11,553	0,0001
<i>TBools</i>	1238	5991	-8,881	0,0001
<i>Bools</i>	4057	8810	-1,662	0,097

Проделанные все расчеты при анализе показателей РИЛ популяций, в соответствующих оптимальном и сухом фоновых режимах орошения по тесту  $U$  критерия Манна-Уитни дали такие же ре-

зультаты как  $t$ -критерий Стьюдента и это показывало того, что в наших исследованиях нами применённые параметрические и непараметрические методы каждый по отдельности подтверждал статистический достоверности полученных результатов.



## Выводы

На основе использованных показателей фенотипов РИЛ сортов линии хлопчатника и полученных результатов расчётов можно сделать следующие заключение.

1. В сравниваемых группах только несколько одноимённые показатели заметно отличались количественно друг от друга, а у многих показателей различие средних значений между фонами оказалось незначительным.

2. Среди сравненных показателей фонов, вода удерживаемости листьев *Water* и транспирации через четырёх часов *Trnspir4h* имели наибольшие разности средних и тем самым они проявили себя как индикаторы засухоустойчивости.

3. Самых высоких значений статистики *t*-критерия с высокими уровнями значимостей ( $P < 0,0001$ ) имели показатели фенотипов вегетационного периода: *Height*, *Hlorophil*, *Simp*, *TwaterPlant*, *TBools* и *Water*.

4. Показатели фенотипов: *Monop*, *Bools*, и *Trnspir1h* имели самого низкого значения статистики *t*-критерия и одновременно оказались статистически недостоверными из-за чего было предпринято попытка применения и непараметрического метода статистики – *U* критерия Манна-Уитни.

5. Программа непараметрического анализа по *U* критерию Манна-Уитни дала такие же результаты как *t*-критерий Стьюдента и указывала на то, что кроме указанных в 4- пункте трёх недостоверных показателей, по всем другим показателям между оптимальным и сухим фонами имеется существенное достоверное различие.

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# ECONOMIC SCIENCES

## КЛЮЧЕВЫЕ МЕТОДЫ СОКРАЩЕНИЯ БЕДНОСТИ: ПРОГРАММЫ ЗАНЯТОСТИ ДЛЯ ПОЖИЛЫХ ЛЮДЕЙ В КАЗАХСТАНЕ

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## KEY METHODS OF POVERTY REDUCTION: EMPLOYMENT PROGRAMS FOR OLDER PERSONS IN KAZAKHSTAN

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### АННОТАЦИЯ

Борьба с бедностью ведется уже много лет. Были достигнуты весьма впечатляющие результаты, но в развивающихся странах еще многое предстоит сделать. Прошедшая пандемия выявила множество слабых мест, последствия которых, по прогнозам мировых институтов, будут ощущаться еще ближайшие пять лет. Программы Всемирного банка ООН ориентированы на социально незащищенное население, в том числе пожилых людей.

В статье раскрываются концептуальные рамки различия между сокращением и борьбой с бедностью, основные измерения и меры бедности. Основное внимание в исследовании уделяется инструментам сокращения бедности для пожилых людей. В основной части текста проведен анализ существующей системы социальной защиты и программ занятости лиц предпенсионного и пенсионного возраста в Казахстане. Анализ охватывает период в 20 лет. Полученные результаты позволяют оценить текущую ситуацию по программам сокращения бедности пожилых людей, на предмет мер принимающихся в Казахстане в ответ на прошедшую пандемию.

### ABSTRACT

The fight against poverty has been going on for many years. Quite impressive results have been achieved, but there is still more to be done in developing countries. The past pandemic has exposed many weak points, the consequences of which will still be felt for the next five years, according to the forecasts of world institutions. UN World bank programs are focused on the socially vulnerable population, including the older people.

The paper reveals the conceptual framework of the difference between poverty reduction and alleviation the main dimensions and poverty measures. The research focuses on tools of poverty reduction for older people as well. In the main part of the text, an analysis on the existing social protection system and employment programs for the pre-retirement and retirement age persons in Kazakhstan was made. The analysis covers a period of 20 years. The results obtained allow us to assess the current situation in the poverty reduction for the elderly in terms of what measures are being taken in Kazakhstan.

**Ключевые слова:** Борьба с бедностью, сокращение бедности, ключевые методы сокращения бедности, пожилые люди, старые люди.

**Keywords:** Poverty alleviation, poverty reduction, key methods of poverty reduction, older persons, elderly people, older people.

## Introduction

More than a billion people at this historical moment are people over 60 years old and unfortunately most of poor elderly people having no satisfactory living conditions live in developing countries. [1]

Although the world community and states managed to reduce the level of extreme poverty from 35% in 1990 to 10% in 2015 the global pandemic and its economic and social consequences may increase the level of poverty. (World Bank, 2022) This is especially true for the elderly, who during the pandemic experienced quite tangible difficulties with health isolation obtaining a stable income and etc. [2] According to the UN older people are persons over 65 years at some national levels this limit varies from 58 to 68 years.

Improving the quality of people's lives is within the framework of poverty alleviation. [3] In the context of this study, it is the improvement of the quality of life of the elderly.

There are conceptual differences between poverty alleviation and poverty reduction frequently used in the literature. Poverty reduction moves an individual or household from poor to non-poor whereas poverty alleviation is a continuous process that reduces living standards and income inequality. [4]

The following approaches to poverty reduction such as economic growth economic reforms micro-finance programs cash transfers are suggested by researches. [5]

At the same time, it is noted that the concept of poverty reduction is much broader than just finance and income although it has a direct and decisive role. It is

multidimensional due to various aspects of well being. [6]

At this stage, there are many measures of poverty, and the official one is based on poverty threshold. It was developed in 1960s and determined those who can be in poverty if their pre-tax income amounts are less than poverty line. [7]

Multidimensional poverty measure was developed by World Bank. Along with monetary deprivation it is including access to education and basic infrastructure. [8]

Based on the mentioned approaches the researchers reveal the following poverty reduction tools for older persons

1. Social protection and retirement benefits [9]
2. Employment opportunities including self employment in the form of small and medium entrepreneurship [10,11]
3. Education programs for older persons (life-long learning) [12]
4. Access healthcare services [13]

In order to analyze poverty reduction tools for the elderly in the case of Kazakhstan, we will consider social security and employment programs in this article.

## Main body

In the Republic of Kazakhstan, special attention has always been paid to ensuring the social protection of citizens without increasing dependency in society.

The country was one of the first in Central Asia to draw a distinction between targeted social assistance and a social risk insurance system. The following social protection systems operate on the principle of compulsory insurance:

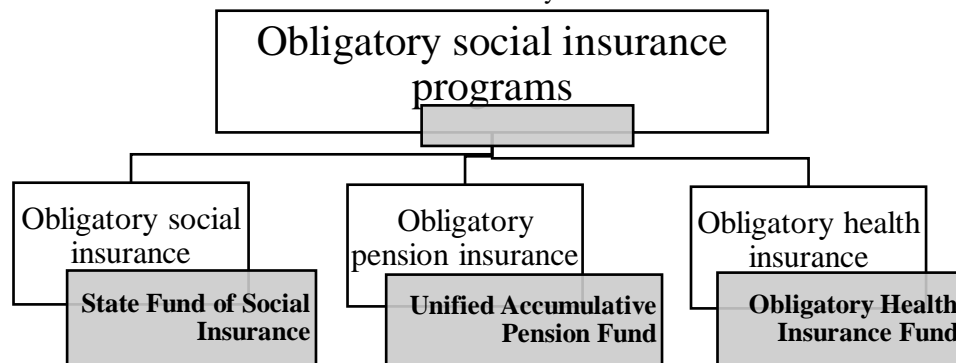


Figure 1 – The main obligatory social programs in Kazakhstan

The social protection based on compulsory social insurance began on January 1, 2005 and for the historical period of 2022 covers more than 6 million people of the working population. While the total annual amount of social payments is approximately 331 billion KZT for 993,000 people. [14]

The State Social Insurance Fund, created specifically for this purpose, has become the main institution for accumulating social contributions. The main payers of social contributions are employers. The algorithm of relations between the main participants in the system of compulsory social insurance is as follows: The employer pays social contributions calculated on the basis of the employee's income in the State Social Insurance Fund through the State Corporation "Government for Citizens". [15] In accordance with the Law of the Re-

public of Kazakhstan "On Compulsory Social Insurance", employees, individuals who are payers of a single aggregate payment, individual entrepreneurs and persons engaged in private practice are subject to compulsory social insurance. [16] Persons of pre-retirement age also participate in the system of compulsory social insurance in case of official employment. Persons of retirement age are covered by compulsory health insurance at the expense of state transfers. [17]

The unemployed population of any age category is regulated by the Law of the Republic of Kazakhstan "On Employment of the Population". Various government programs have been implemented for 20 years to promote the employment of citizens. Such policy not only prevented the growth of unemployment, but also achieved a decrease in its level, even in times of crisis.

At the beginning of 2000<sup>th</sup> the Program for Combating Poverty and Unemployment was implemented. It was aimed at ensuring the employment of at least one member of each family in Kazakhstan and assumed the creation of new jobs. [18]

Over time new employment programs were developed. It contains a number of active policies (measures) for vocational training and retraining subsidizing jobs increasing the territorial mobility of workers supporting entrepreneurship through the issuance of grants concessional lending and training in the basics of doing business.

At the moment the project "Program to increase the income of the population until 2025" is operating, which replaced the state program for the development of productive employment and mass entrepreneurship "Enbek" for 2017 – 2021. It should be noted that in the last developed program attention was paid to the socially vulnerable segment of the population including the older people. Within the framework a special project "Silver Age" was developed in order to provide employment for unemployed people of pre-retirement age. The essence of the project is that the employment center will subsidize part of the salary of a person of pre-retirement age at the expense of the budget. The monthly amount of wage subsidies is 50% of the salary, but not more than 30 MCI, including taxes, mandatory social contributions, and compensation for unused vacation and banking services, excluding payments for environmental allowances. [18]

The participation in the Silver Age project is up to 12 months. After the completion, the employer hires a person of pre-retirement age on a permanent basis. It should not be harmful and dangerous working conditions.

Also, along with this, the Active Longevity program until 2025 has been developed for the elderly. The creation of active longevity centers are financed by local municipalities. The centers help older people to maintain their health, involving them in public life. Yoga classes Nordic walking and dancing are held free of charge. Pensioners are provided with medical psychological and legal consultations as well as they are taught IT and smart literacy foreign languages. The centers organize field events visits to cultural sites hold themed concerts and events.

In general the priorities of the healthy aging policy for Kazakhstan were determined. After all the formation of a society of active, healthy and dignified longevity involves actions in the following areas:

- Health: healthy lifestyle prevention and treatment of diseases rehabilitation and prevention of complications after illnesses.
- Integration (inclusion): ensuring the feasible participation of older people of any age up to the very late one in various spheres of society social economic cultural spiritual political etc. and at various levels from the family to the national level.
- Improving the social security system and planning measures to strengthen its adequacy equity and sustainability.
- Improving the system of providing social services.

- Strengthening intergenerational harmony and cooperation, based on the historical and cultural traditions of the country and taking into account the ongoing changes in the country and the world.

- Individual development: the opportunity to do what you love, while maintaining interest in life and satisfaction with its quality until its completion.

- Education throughout life.

- Ensuring the rights of the elderly and preventing ageism.

### Conclusion

The literature review with selected keywords on the conceptual framework for poverty reduction was carried out. Along with economic growth, the studies advised to pay attention to the instruments of poverty reduction. Not all of them are suitable for older people. The article analyzed the existing measures to reduce poverty, taking into account the past pandemic. The main provisions of social protection institutions in Kazakhstan were explained. There are three main social obligatory insurance systems in Kazakhstan, such as social health and pension systems. The experience of using employment programs for the older people for was analyzed. Longevity programs are also quite successfully implemented and working.

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## ЭФФЕКТИВНОСТЬ ИСПОЛЬЗОВАНИЯ ОБОРОТНОГО КАПИТАЛА – КАК ГЛАВНОЕ УСЛОВИЕ УСПЕШНОЙ ДЕЯТЕЛЬНОСТИ ПРЕДПРИЯТИЯ

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## EFFICIENCY OF USE OF WORKING CAPITAL - AS THE MAIN CONDITION FOR SUCCESSFUL ACTIVITIES OF THE ENTERPRISE

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### АННОТАЦИЯ

Оборотные активы являются одной из составных частей имущества предприятия. Состояние и эффективность их использования - одно из главных условий успешной деятельности предприятия. Инфляция, неплатежи и другие кризисные явления вынуждают компании изменять свою политику по отношению к оборотным активам, искать новые источники пополнения, изучать проблему эффективности их использования.

### ABSTRACT

Current assets are one of the components of the property of the enterprise. The condition and efficiency of their use is one of the main conditions for the successful operation of the enterprise. Inflation, non-payments and other crisis phenomena are forcing companies to change their policy in relation to current assets, look for new sources of replenishment, and study the problem of their efficient use.

**Ключевые слова:** предприятие, оборотные средства, производственные фонды, ресурсы, оборотные фонды, кругооборот фондов.

**Keywords:** enterprise, working capital, production assets, resources, working capital, circulation of funds.

### Introduction

One of the conditions for the continuity of production is the constant renewal of its material foundation - the means of production. In turn, this predetermines the continuity of the movement of the means of production

themselves, which occurs in the form of their circulation.

In its turnover, current assets consistently take on a monetary, productive and commodity form, which corresponds to their division into production assets and circulation funds.

The material carrier of production assets are the means of production, which are divided into objects of labor and tools of labor. Finished products, together with cash and funds in the calculations, form the circulation funds.

The circulation of funds of enterprises begins with the advance of value in cash for the purchase of raw materials, materials, fuel and other means of production - the first stage of the circuit. As a result, cash takes the form of inventories, expressing the transition from the sphere of circulation to the sphere of production. In this case, the value is not spent, but is advanced, since after the completion of the circuit it is returned. The completion of the first stage interrupts commodity circulation, but not circulation.

The second stage of the circuit takes place in the process of production, where the labor power carries out the productive consumption of the means of production, creating a new product that carries in itself the transferred and newly created value. The advanced value again changes its form - from a productive one it passes into a commodity one.

The third stage of the circulation is the sale of manufactured finished products and the receipt of funds. At this stage, working capital again moves from the sphere of production to the sphere of circulation. The interrupted circulation of commodities is resumed, and value passes from the commodity form into the monetary form. The difference between the amount of money spent on the manufacture and sale of products and received from the sale of manufactured products is the cash savings of the enterprise.

Having completed one circuit, working capital enters a new one, thereby carrying out their continuous circulation. It is the constant movement of working capital that is the basis for an uninterrupted process of production and circulation.

An analysis of the circulation of enterprise funds shows that the value advanced not only successively assumes various forms, but also constantly remains in these forms to a certain extent. In other words, the value advanced at each given moment of the circuit is in various parts at the same time in the form of money, production, and commodities.

The circulation of funds of enterprises can only be carried out if there is a certain advanced value in the form of money. Entering the circuit, it no longer leaves it, consistently changing its functional forms. The stated value in cash represents the company's current assets.

Current assets act primarily as a value category. In the literal sense, they are not material values, since they cannot be used to produce finished products. Being value in monetary form, current assets already in the process of circulation take the form of inventories, work in progress, finished products. Unlike inventory items, working capital is not spent, not expended, not consumed, but advanced, returning after the end of one circuit and entering the next.

The moment of advance is one of the essential and distinctive features of current assets, as it plays an important role in establishing their economic boundaries. The time criterion for advancing current assets should

not be the quarterly or annual volume of funds, but one cycle, after which they are reimbursed and enter the next.

The study of the essence of current assets involves consideration of working capital and circulation funds. Current assets, revolving funds and circulation funds exist in unity and interconnection, but there are significant differences between them, which boil down to the following.

Current assets are constantly at all stages of the enterprise, while the working capital goes through the production process, being replaced by new batches of raw materials, fuel, basic and auxiliary materials. Inventories, being part of working capital, go into the production process, turn into finished products and, as a result, leave the enterprise. Working capital is completely consumed in the production process, transferring its value to the finished product. Their sum per year can be dozens of times greater than the amount of working capital, which, during each circuit, ensures the processing or consumption of a new batch of objects of labor and those remaining in the economy, making a closed circuit.

Revolving funds are directly involved in the creation of new value, and working capital - indirectly, through revolving funds.

In the process of circulation, circulating assets embody their value in circulating assets and therefore, through the latter, they function in the production process and participate in the formation of production costs.

If circulating assets directly and directly participated in the creation of a new product, then they would gradually decrease and by the time the cycle ends they should have disappeared.

Revolving funds, representing use value, act in a single form - productive. Current assets, as noted, not only consistently take on various forms, but also constantly in certain parts are in these forms.

These circumstances create an objective need to distinguish between the turnover of working capital and current assets.

Comparison of circulating assets with circulation funds, which are a functional form of circulating assets at the circulation stage, leads to the following results. The circulation of funds of enterprises ends with the process of selling products. For the normal implementation of this process, they, along with the main and circulating funds, must have circulation funds.

The turnover of circulation funds is inextricably linked with the turnover of circulating production assets and is its continuation and completion. Making a circuit, these funds are intertwined, forming a common turnover, in the process of which the value of circulating funds, transferred to the product of labor, passes from the sphere of production to the sphere of circulation, and the value of the circulation funds in the amount of the advanced value - from the sphere of circulation to the sphere of production. This is how a single turnover of advanced funds is carried out, passing through different functional forms and returning to the original monetary form. Working capital, making a circuit, from the sphere of production, where they function

as working capital, pass into the sphere of circulation, where they function as circulation funds.

The definition of current assets as advanced funds in the created stocks of circulating production assets and circulation funds does not reveal the full economic content of this category. It does not take into account that, along with the advance of a certain amount of money resources, the process of advancing into these stocks of the value of the surplus product created in the production process takes place. Therefore, for profitable enterprises, after the completion of the circulation of funds, the amount of advanced working capital increases by a certain amount of profit received. In unprofitable enterprises, the amount of advanced working capital at the end of the circulation of funds decreases due to the losses incurred.

We often equate current assets with cash. Meanwhile, it is impossible in the literal sense to call them money. The funds employed in production and circulation should not be identified with money. The total value is advanced in the form of money, and, having passed through the process of production and circulation, it assumes that form again. Cash is thus an intermediary in the movement of funds. The total value, expressed in money, turns into real money only occasionally and piecemeal.

So, current assets represent the value advanced in monetary form for the systematic formation and use of working capital and circulation funds in the minimum required amount to ensure the implementation of the production program by the enterprise and the timeliness of settlements.

Current assets of companies perform two main functions: production and settlement. Performing a production function, circulating assets, being advanced in circulating production assets, maintain the continuity of the production process and transfer their value to the

manufactured product. Upon completion of production, current assets pass into the sphere of circulation in the form of circulation funds, where they perform a second function, consisting in the completion of the circulation and the transformation of current assets from a commodity form into a monetary form.

#### Conclusion

Rhythm, coherence, high performance and efficiency of the enterprise largely depend on its availability of working capital. The lack of funds advanced for the purchase of inventories can lead to a reduction in production, as well as non-fulfillment of the production program. As a result, excessive diversion of funds into reserves that exceed the actual need can lead to deadening of resources and their inefficient use.

Since current assets include both material and monetary resources, not only the process of material production, but also the financial stability of the company as a whole depends on their organization and efficiency of use.

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**ДІЯЛЬНІСТЬ НАЦІОНАЛЬНОГО БАНКУ УКРАЇНИ З УПРАВЛІННЯ  
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CURRENCY RESERVES****Korol M.***Doctor of Economics, Professor,  
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Uzhhorod National University, Ukraine*DOI: [10.5281/zenodo.7298620](https://doi.org/10.5281/zenodo.7298620)**Анотація**

У статті проаналізовано структуру золотовалютних резервів України. Охарактеризовано етапи розвитку вітчизняної банківської системи. Підкреслено, що саме завдяки правильному формуванню та ефективному використанню золотовалютних резервів можливе стабільне функціонування фінансової системи. Особливу увагу приділено індексу фінансового стресу. Відзначено, що після вторгнення росії в Україну 24 лютого 2022 році відбулося різке підвищення значення індексу, зростали всі його складові, що свідчить про системний характер стресу для фінансового сектору.

**Abstract**

The structure of Ukraine's gold and foreign exchange reserves is examined in the article. The stages of development of the domestic banking system are identified. It is emphasized that stable financial system operation is possible due to the proper formation and effective use of gold and foreign exchange reserves. The financial stress index receives special consideration in the paper. It was determined that following Russia's invasion on February 24, 2022, to Ukraine there was a significant increase in the value of the index, with all of its components rising, indicating the systemic nature of stress for the financial sector.

**Ключові слова:** центральний банк, золотовалютні резерви, Національний банк України, індекс фінансового стресу.

**Keywords:** central bank, gold and foreign exchange reserves, National Bank of Ukraine, financial stress index.

В країнах світу структура та функції центральних банків визначалися протягом досить довгого історичного періоду під впливом унікальних для кожної країни історичних, політичних, економічних та інших факторів. Але незважаючи на різний ступінь економічного розвитку та особливості грошово-кредитної політики, практично всі країни світу формують золотовалютні резерви. Управління золотовалютними резервами унікальне для кожної країни.

Україна – молода держава. Українська банківська система утворилася у 1991 році в результаті розпаду СРСР. Як новостворена держава, Україна не мала власних золотовалютних резервів, а отже й досвіду управління ними, не було ні кадрів, ні інфраструктури. У Радянському Союзі основним джерелом поповнення золотовалютних резервів були валютні надходження від експорту сировини, енергоносіїв, корисних копалин та власний видобуток золота, і використовувались для фінансування імпорту товарів, продовольства та політичних заходів за кордоном, тобто просто "проїдалися" [1].

У грудні 1991 року був створений Національний банк України на базі українського республіканського відділення Держбанку СРСР. З цього часу почався процес розбудови механізму управління золотовалютними резервами, який проходив у чотири етапи [2].

Перший етап охоплює період з часу створення Національного банку України і закінчується організацією Валютної біржі НБУ (1992 р.). Найважливішими завданнями на цьому етапі було створення інфраструктури управління золотовалютними резервами, встановлення кореспондентських відносин НБУ з іноземними банками, підготовка кваліфікованого персоналу.

Другий етап тривав з 1992 до 1995 р. (початок кредитування України Міжнародним валютним фондом). Для цього етапу характерними є дві особливості: активне формування нормативно-правової бази з питань валютного регулювання та валютного контролю в Україні і швидке зростання золотовалютних резервів НБУ завдяки впровадженню обов'язкового продажу частини валютних надходжень.

Третій етап (1995-1998 рр.) пов'язаний зі стрімким зростанням обсягів золотовалютних резервів за рахунок надходження кредитів МВФ та короткострокових портфельних іноземних інвестицій. Завершується цей етап фінансовою кризою 1998 р.

Четвертий етап (з 1998 р. і до теперішнього часу) виявив недоліки існуючої системи управління золотовалютними резервами НБУ, зокрема [3]:

- низьку ліквідність резервів, що обумовлено використанням довгострокових фінансових інструментів;
- проведення операцій з офшорними банками;
- недостатній рівень контролю за ризиками НБУ.

Відповідно до нормативно-правових актів Національного банку України золотовалютний резерв - це частина національного багатства України, до складу якої входять активи, визнані світовим співтовариством як міжнародні і яка перебуває під контролем Національного банку та призначена для прямого чи непрямого регулювання платіжного балансу шляхом проведення валютних інтервенцій та інших цілей, передбачених законодавством України [4; 5].

Офіційні золотовалютні резерви Національного банку України містить такі активи:

- монетарне золото;
- спеціальні права запозичення;
- вільно конвертовану валюту у вигляді банків, монет, інших платіжних інструментів, а також коштів на рахунках і депозитах в іноземних банках;
- векселі, ноти, облігації (крім емітованих резидентами України), номіновані у вільно конвертованій валюті;
- інші вимоги у вільно конвертованій валюті, передбачені чинним законодавством України.

Основними резервними валютами для Національного банку є долари США, євро, СПЗ, швейцарські франки, англійські фунти стерлінгів, япон-

ські єни. Як базова валюта, тобто як валюта для підрахунку обсягу, визначення структури золотовалютного резерву, а також для складання звітності для міжнародних фінансових організацій використовується долар США.

Обсяги золотовалютних резервів України в період з 1999 по 2007 роки невинно збільшувалися і досягли розмірів 32,5 млрд. дол. США. У зв'язку з світовою фінансовою кризою 2008-2009 років, розміри ЗВР зменшилися до 26,5 млрд. дол. США у 2009 році. Далі з 2011 до 2014 року золотовалютні резерви України досягли свого історичного мінімуму у розмірі 7,5 млрд. дол. США у зв'язку з економічною, політичною та військовою ситуацією в країні. Надалі в період з 2015 року (13,3 млрд. дол. США) по 2018 роки відбувалися коливання у розмірах золотовалютних резервів.

Станом на серпень 2022 року золотовалютні резерви України складають 25,4 млрд. дол. США. А вже в жовтні 2022 року їх розмір зменшився до 23,9 млрд. дол. США. У структурі золотовалютних резервів України найбільшу частку станом на серпень 2022 року займають цінні папери (13,3 млрд. дол. США), наступними йдуть валюта та депозити (8,8 млрд. дол. США), СПЗ (1,9 млрд. дол. США), монетарне золото (1,5 млрд. дол. США) та резервна позиція МВФ (0,31 млн. дол. США) (офіційний сайт нбу).

За джерелом формування кошти золотовалютного резерву поділяються на власні та залучені. До власних належать кошти, одержані від:

- купівлі іноземної валюти на валютних ринках;
- купівлі вільно конвертованої валюти в органів державної влади й управління та інших клієнтів, розрахунково-касове обслуговування яких здійснює Національний банк;
- купівлі монетарного золота у зливках або брухту золота з його подальшим доведенням (афінажем) до якості монетарного металу;
- доходу від здійснення операцій із золотовалютним резервом.

Серед залучених коштів виділяють:

- кредити міжнародних фінансових організацій, урядів іноземних країн, фінансово-кредитних установ, інших кредиторів;
- депозити фінансово-кредитних установ;
- залишки коштів у вільно конвертованій валюті на рахунках органів державної влади й управління та інших клієнтів, розрахунково-касове обслуговування яких здійснює Національний банк.

Переважна частина монетарного золота НБУ зберігалася у сховищі Державної скарбниці, решта була розміщена у довгострокові депозити [6].

Основними завданнями Національного банку України, щодо формування структури золотовалютних резервів за складом валютних активів, які до них включаються, є [7]:

- відповідність цієї структури спрямуванню платежів за зовнішньоекономічними операціями та обслуговуванню зовнішнього боргу;
- недопущення знецінення резервних активів унаслідок коливання курсів різних валют;

- забезпечення по можливості прийнятного рівня дохідності вкладень, розміщених у валютних активах, за мінімального ризику.

З 2016 року Національний банк України впроваджує розрахунок Індексу фінансового стресу

(ІФС), що вимірює рівень напруги фінансової системи і надає комплексну кількісну оцінку її стану, він наведений на рис. 1.

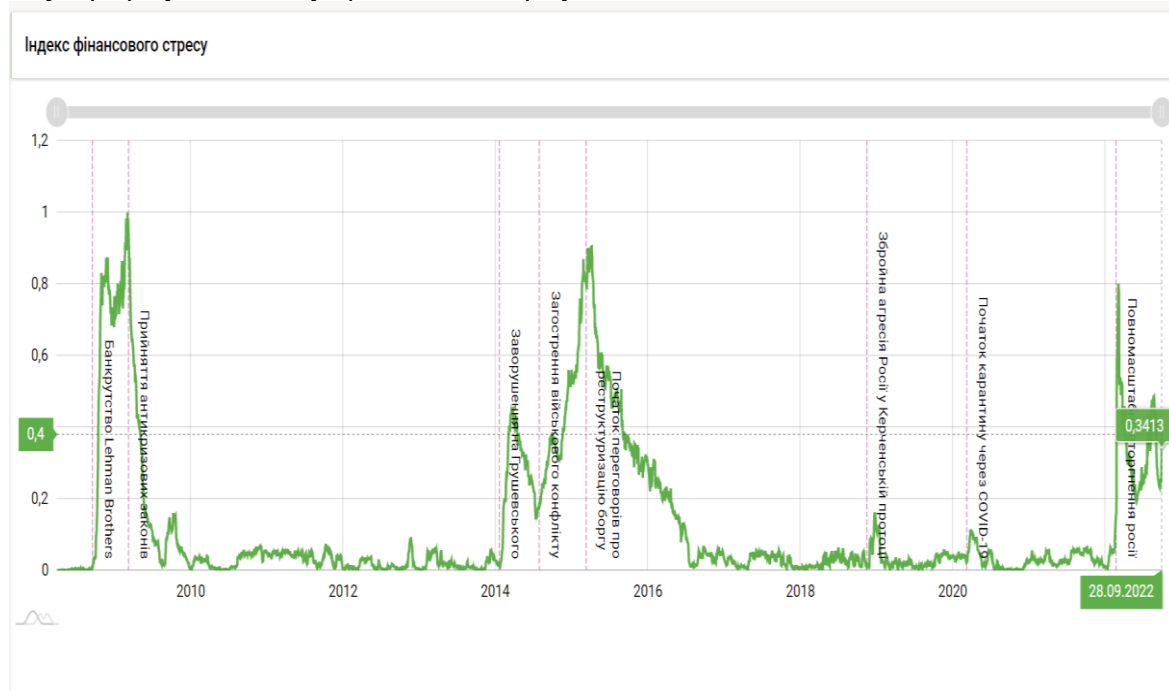


Рис. 1 Індекс фінансового стресу НБУ, 2008 – 28.09.2022 рр.

Джерело: [8]

Аналізуючи рис. 1 можна констатувати, що перше значне підняття індексу фінансового стресу відбулось у листопаді 2008 року після банкрутства "Lehman Brothers". Далі цей індекс почав зростати у зв'язку з світовою фінансовою кризою (приблизно 0,63), але після прийняття антикризових законів за вимогою МВФ індекс впав до показників (0,1 – 0,2) і коливався у цих межах до листопада 2013 року до початку Революції Гідності, після чого почав зростати.

Після переговорів про реструктуризацію боргів та виборів президента індекс знизився. Але через початок агресії росії та військового конфлікту з нею індекс знову різко зріс та досяг значення у 0,5. З початком переговорів з міжнародними кредиторами у листопаді 2015 року та подальшими домовленостями про реструктуризацію боргу, націоналізації "Приватбанку" індекс фінансового стресу почав знижуватись.

Вторгнення росії у 2022 році спричинило різке підвищення значення індексу. Зростали всі його складові, що свідчить про системний характер стресу для фінансового сектору. Спершу високі значення ІФС визначалися зростанням дохідностей на ринку цінних паперів, волатильністю курсу на готівковому валютному ринку, високим рівнем валютних інтервенцій та рефінансування банків Національним банком для підтримання їх ліквідності. Порівняно низьким залишався лише рівень субіндексу поведінки домогосподарств завдяки тому, що збереглася довіра населення до банківської системи і не було відпливу вкладів, що стримало зростання загального індексу. Згодом

значення більшості субіндексів зменшилися. Проте вже в липні в очікуванні реструктуризації державного боргу дохідність державних та корпоративних цінних паперів стрімко зросла. Ставки за депозитами населення також зростали, волатильність на готівковому валютному ринку зберігалася. Відтак ІФС підвищився до безрешного рівня [8].

Для розрахунку індексу виділено чотири сектори фінансового ринку: банківський, корпоративних цінних паперів, державних цінних паперів та валютний. Для кожного сектору розраховується окремий субіндекс, який має власну вагу і складається з декількох фінансових індикаторів, що відображають стан цього сектору, а їх значення залежить від поведінки гравців ринку [9].

Підсумовуючи все вищесказане можна зробити висновок, що одним із головних завдань Національного банку України є ефективне управління офіційними золотовалютними резервами країни. Цілями є забезпечення покриття дефіциту платіжного балансу країни і вплив на обмінний курс через девізну політику, а також вплив на динаміку обсягів грошової маси всередині країни з метою досягнення цінової стабільності як стратегічної мети грошово-кредитного регулювання загалом.

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## DIGITALIZATION AS THE BASIS OF THE DEVELOPMENT OF ENTERPRISES IN THE HOSPITALITY INDUSTRY

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### ABSTRACT

Digitization is becoming the main trend, which is clearly manifested in the distribution models of hotel services, and is also actively entering the field of automation of internal business processes. The number pool and public areas are also automated. Today, a modern hotel is a place where everything is created exclusively for the convenience and comfort of customers. Digital innovations are gradually becoming the new standard of hotel service. But in addition to two obvious trends - the development of mobile services for guests and the launch of services based on gadgets, the digitalization of hotels also includes the implementation of advanced solutions for analytics and security.

**Keywords:** digitization, automatic systems, hotel and restaurant business, tourism, hospitality industry.

### Formulation of the problem.

Information technologies are of great importance for almost all spheres of the economy. In today's conditions, these technologies have found widespread use in the hospitality industry, and the artificial intelligence market is growing every year. In order to be commercially successful in today's economic conditions, various significant innovative computer technologies (clouds, mobile services, big data analytics, highly loaded systems) have been developed. In today's conditions, the hospitality industry is a branch of economic activity that provides a tenth of the global gross product and is developing at a rapid pace and in the coming years may become one of the most important sectors of business activity. The hospitality industry is the field of meeting the needs of services related to recreation and organization of activities during travel.

POS systems, hotel digital security systems are responsible for collecting and analyzing different levels of visitor data. Using this information, hotels can encourage regular customers and draw conclusions about customer behavior and preferences, prepare advanced analytics. Digital security systems can not only monitor the smallest violations of public order, but also, for example, provide additional information.

### Analysis of recent research and publications.

To date, the issues of the article have been sufficiently well researched and the research results have been reflected in the works of such authors as M. Burgin, L. Vashchenko, G. Gerasimova, L. Danylenko, L. Podymova, O. Popova, A. Khutorskyi, A. Nikols and other. The study of the problems of the development of the tourism and hotel-restaurant industry has received great attention from domestic scientists and specialists,

namely: O. Golovko, G. Krul, M. Malska, L. Nechayuk, O. Shapovalova.

#### **The purpose of the work.**

The problems and prospects of the development of the market of information and information technologies at enterprises of the hospitality industry are considered.

#### **Results.**

The hospitality industry is one of the main components of the economy of Ukraine. In today's conditions, the service sector, like any other, is constantly transformed under the influence of globalization and integration of processes. Thus, the effective functioning of the hospitality industry is an indicator of positive changes in the state's economy, an important prerequisite for the intensification of international relations and the country's integration into the world community [1].

The modern informational development of society is undergoing innovation-technological, oriented transformations, in particular, this applies to the service sector. The main goal of these transformations is primarily convenience, accessibility, mobility, awareness and good relations with its customers.

Monitoring and analysis of the global experience of hospitality industry enterprises demonstrates a constant increase in the popularity of this business sector and causes an increase in the harshness of survival conditions. This situation forces institutions to constantly turn to innovative technological developments in order to maintain competitiveness in the market, fight for the loyalty of the guest, improve the quality of service, and also expand the range of services provided.

Constantly growing competition in the service market requires special uniqueness and individuality from service companies. It is the innovative approach to the introduction of the latest information developments in the activities of hospitality industry enterprises that is a necessary condition for their effective functioning. The introduction of new information services and products will contribute to the effective use of all opportunities for quality service and maximizing the potential of the hospitality industry.

The introduction of the latest information technologies in the development of production or in the management of enterprises of the hospitality industry makes it possible to significantly increase the efficiency and effectiveness of work, through best practices, management methods or scientific knowledge. The advantage in terms of relevance is given to information technologies, since their use is a necessary condition for the functioning of any modern means of accommodation or catering enterprise, ensuring accuracy, efficiency, high speed of processing and transmission of information [3].

To ensure leadership and obtain competitive advantages in the market of hotel and restaurant services, it is necessary to use computer networks, Internet technologies, end-to-end automation of all business processes [4].

Innovative activity is an important means of maintaining the level of competitiveness of any economic system [2, 4]. However, the implementation of information innovations in the practice of hospitality industry enterprises faces a number of factors, such as the

risk of loss of capital investments, lack of experience with the introduction of innovations, lack of stimulation of innovations by the state, limited financial resources of entrepreneurs, high cost of innovative developments, etc. [5].

Online services are the main area where information technology advances are transforming the hospitality industry and bringing customer service to a qualitatively new level.

The use of information technologies for processing and transmitting information at enterprises in the service sector allows creating an innovative and adapted to modern conditions tourism product, which aims to increase competitiveness and, accordingly, increase the rate of expected profitability.

Specialists of the modern information sphere are sure that no company in the hospitality industry can do without the use of computer systems in today's conditions. Increasing the value of information as a product determines the progressive development of the information services industry in the hotel and restaurant industry. Ensuring a high level of guest service at enterprises of the hospitality industry in modern conditions cannot be achieved without the use of innovative technologies that involve the automation of many processes, electronic reservation, and the introduction of technologies that improve the quality of service while reducing staff [3].

The constantly progressive development of modern information technologies led to the emergence of completely new integrated computer management systems for enterprises in the hospitality industry. Today, systems based on the application of networks of personal computers and mini-computers with a developed interface are widely used [2]. This information flow makes it possible to exchange information.

One of the newest information technologies of today is SMM (Social Media Marketing) - the most popular type of promotion and trade of tourist products through social networks. It does not require large costs, is effective in use and easy to master for the personnel of service enterprises. Its main goal is to create individuality, recognition, branding of the enterprise; increasing interest in the services provided, facilitating communication with clients, expanding the client base and potential opportunities of the enterprise.

Promotion of hotel and restaurant services in social networks is necessary in order to find potential guests and increase the loyalty of regular customers. In other words, a good service social media profile should attract guests visually: good photos of food, videos of events, photos of staff and guests. Also, social networks are the latest platform for advertising mailings and integrations. Such advertising activity allows you to significantly save the budget and get a more effective result.

Businesses in the hospitality industry need SMM for the following purposes:

- to form a brand image;
- attract new customers;
- inform and maintain communication with guests;
- collect reviews.

Today, many enterprises of the hospitality industry have their profiles on such social networks as "Instagram" and "Facebook". This requires constant efforts to maintain a correct profile, update information and promote on online platforms. Also, these profiles provide an opportunity to quickly react to market changes:

- brand promotion;
- increasing the loyalty and popularity of the product/service;
- order service online;
- responding to feedback and suggestions;
- conducting raffles or quizzes with the aim of attracting new users of services (giveaway);
- increase in website traffic;
- providing services in compliance with quarantine requirements (ordering food online, food boxes, booking tickets, reserving tables in a restaurant, etc.).

The goods of service enterprises in SMM are the same services and goods that are presented in ordinary marketing. But it is Internet marketing that helps promote products, analyze the demand and supply of competitors, and in some cases test the product [3]. This type of marketing is a modern and extremely effective communication tool of a hotel or restaurant because the page/site has an optimal structure, all sections contain only relevant information that is constantly updated [6].

This type of information innovation had no effect on the price change. And the choice of products or services has become easier and more accessible for consumers.

Social Media Marketing makes it possible to choose the target audience in a more targeted manner, to choose relevant platforms where exactly this audience is represented to a greater extent. Due to high development rates, hospitality industry enterprises that have profiles in social networks are less sensitive to the crisis.

SMM first of all requires the latest knowledge and skills to work on online platforms. So, to promote a hotel or restaurant page in social networks, you need the following: determine the target audience, choose the appropriate social network, draw up a content plan, etc. To draw up a content plan, you must first determine what potential consumers of hotel and restaurant services need to know, and then divide the content into categories and formats. After the rubrics are formed, it is worth starting to develop the content plan of the enterprise. It can be laid out in calendar format or as a table.

A restaurant's content plan shouldn't be limited to just posts about food: posts can include information about different types of food, ingredients, veganism, favorite foods, even the features and history of the building in which the restaurant is located.

It is worth noting that the ever-increasing digitalization of all processes, especially in the enterprises of the hospitality industry, is increasingly embracing the digital environment, forming new boundaries of customer experience. At the same time, the customer experience is understood as the whole set of emotions, impressions and knowledge of the customer, which he receives at various points of contact (touchpoint) with the enterprise of the hotel and restaurant business (both real and virtual) [4].

SMM technologies at enterprises in the service sector contribute to strengthening the emotional connection with the client, increasing client orientation and helping to overcome all modern crisis situations with less losses.

Online booking is one of the latest information technologies that is being actively implemented in the activities of hospitality industry enterprises. Most service representatives now consider it necessary to have an online booking option for customers. This service requires qualitatively developed software: appropriate mobile applications and sites with a simple interface [6].

Modern enterprises of the hospitality industry are a complex complex of functional links. Taking into account the ever-growing competition and the latest directions in the field of service, the need to create conditions for prompt and efficient work of personnel increases. The solution to this problem is possible only through the implementation of hotel automation systems, that is, the introduction of Automated Management Systems (ACS) by the hotel (in the English version - Property Management System (PMS)) [3].

Automated management systems for hospitality industry enterprises are a complex of integrated subsystems that create an effective environment for the interaction of employees, clients and business partners - travel agencies, corporate clients and tour operators [2, 6].

Today, the most common automated hotel systems used in global practice are [1, 4]:

- Hotel management system (PMS - Property Management System);
- Restaurant management system (Point Of Sales);
- Event management system (Sales & Catering);
- Telephone service system (Telephone Management System);
- System of electronic keys (Key System);
- System of electronic minibars (Mini bar System);
- System of interactive television (Video Services System);
- Energy management system (Energy Management System);
- Credit Card Authorization System;
- Warehouse accounting and costing system (Food & Beverage);
- Financial accounting system (Accounting System);
- Central Reservation System (Central Reservation System);
- Internet reservation system (Web Reservation System);
- Personnel accounting system (Human Resource System);
- Security System (Security System).

Virtually all Western hotel software vendors have a version of their PMS specifically designed for remote use. These systems are developed using Internet technologies: ASP (Application Server Provider) and "client-server" based on SQL (Standard Query Language) [2].

One of the most common ACS today is the Amadeus system. It was created in 1987 by the largest European airlines Air France, Iberia, Lufthansa, SAS and is one of the largest and most widespread reservation systems. The network center is located in Germany

(near Munich) and is connected to users all over the world thanks to its own reliable, high-speed communication network. It allows travel agencies to offer a full set of programs and the possibility of booking hotel seats, which ensures that enterprises are more flexible and productive in the modern service market [3].

*Amadeus is now the leading computer reservation system in Europe. As a result of the acquisition of the System One reservation system in 1995, it is actively advancing to the American market.*

*Amadeus provides a variety of services, including cooperation with airlines, railway and ferry transportation, car rental, hotels, and also provides additional services, such as tourist insurance, etc. Amadeus is used by more than 30,000 travel agencies (more than 100,000 terminals), more than 400 airlines (more than 60,000 terminals).*

*More and more companies in the hospitality industry are turning to Amadeus services. This system provides open access to online booking 24/7, 365 days a year.*

*The basic advantages of the Amadeus system are:*

- *saving time due to the openness and availability of tourist, client and agency information;*
- *cost savings due to maximum efficiency as a result of stable operation and immediate confirmations;*
- *constant monitoring and control of the integrated flexible system meets all the needs of the agency in the work process;*
- *hourly updating of relevant information in real time;*
- *increase in income due to a wide range of opportunities that ensure the satisfaction of the entire range of customer orders [4].*

*Automated management systems of hospitality industry enterprises in today's conditions should not be products that are aimed exclusively at internal processes. It is important to ensure their relationship with external sources. Among the main ones [3]:*

- *payment systems - guests should be able to make payments using all available methods, for which it is necessary to install fiscal registers in the hotel;*
- *security and safety - we are talking about gaining access to certain premises, control of visits by outsiders;*
- *energy saving - hotel engineering systems and equipment are connected to the general automation program, this will save resources (for example, turning off power to unoccupied rooms, setting the desired temperature level depending on the presence or absence of a guest in the room);*
- *GDS systems - if the establishment is registered in them, then the internal automated hotel management systems must transfer the changed data about the room stock (occupied or free, price, etc.) to external global*

*platforms, which will avoid overbooking (using the Channel Manager tool).*

*Modern service IT technologies are global reservation systems and CRM systems. They allow the client to choose the most convenient accommodation option for himself, taking into account all the advantages. The basis of CRM technology is the accumulation of information about the client and the management of this data. Customer databases make it possible to study the hotel's target audience in detail, forecast the demand for services, and conduct an effective marketing policy.*

*Conclusions. Therefore, the key basis for ensuring competitiveness, constant development and increasing the efficiency of the functioning of enterprises of the hospitality industry in Ukraine is the introduction of information technologies. This is cost-effective and efficient, as they contribute to improving the service process, reducing costs and generating additional income.*

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# GEOLOGICAL AND MINERALOGICAL SCIENCES

## WHY WERE REEFS AND STROMATOPOROIDS SO RARE IN THE LOWER DEVONIAN?

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### ABSTRACT

In the middle Lower Devonian, the Pragian, reefs were very rare worldwide and stromatoporoids were rare and little diverse. As an explanation for this phenomenon, it is not sufficient that the global sea level had its low for the Devonian period during the Pragian and Lower Emsian. Therefore, three stromatoporoid-bearing reefs from the Pragian of Western and Central Europe were studied: Koněprusy in the Czech Republic, Seewarte in Austria and Zújar in Southern Spain. The following possible causes for the extreme rarity of reefs in the Pragian emerged: 1) Conspicuously high or low water temperatures that were not conducive to the growth of stromatoporoid reefs. 2) Stromatoporoid groups, which were of central importance in the Givetian and Frasnian reefs, were only at the beginning of their evolution and expansion in the Pragian – particularly mentioned are the branching stromatoporoids, the thinly encrusting stromatoporoids and the order Stromatoporellida. 3) There is evidence that the *Syringopora* commensals increased the reef-building potential of the stromatoporoids. There seems to have been a break in the *Syringopora* commensalism of the stromatoporoids in the uppermost Silurian or deepest Devonian. In the Pragian, *Syringopora* commensals were very rare and the Devonian *Syringopora* commensalism began with the primitive initial stage of *Syringopora praehanshanensis* May, 2005.

**Keywords:** Pragian; reef evolution; stromatoporoid fauna; *Syringopora* commensalism; water temperature.

### 1. Introduction

While reefs built up by stromatoporoids were widespread and common in the Silurian, they became rare at the end of the Silurian due to global regressions [1, p. 113–163; 2, p. 34]. In the lower and middle part of the Lower Devonian, reefs were extremely rare worldwide [3]. When reefs did occur in the lower and middle part of the Lower Devonian, they were in many cases composed of a strikingly large proportion of algal and microbial communities [4; 5]. In parallel, Lower Devonian stromatoporoids showed drastically reduced diversity and abundance worldwide [6, p. 229; 7, p. 10–13; 8, p. 257–258; 9, p. 282–285]. In the upper part of the Lower Devonian, reefs and stromatoporoids increased in abundance again. In the Middle Devonian and lower Upper Devonian, reefs and biostromes of stromatoporoids and corals were widespread and common worldwide and constituted the acme of Palaeozoic reef formation in the Givetian–Frasnian [3; 10; 11; 12]. This reef-building phase was abruptly ended at the end of the Frasnian by the “Late Devonian Major Ecological Crisis” (372 Ma) [2, p. 35; 13; 14, p. 4–5; 15].

May and Rodríguez [16, p. 230–231] elaborate that the roots of the Middle Devonian reefs extend into the Pragian. They list various genera of stromatoporoids, rugose corals and tabulate corals that were important reef builders in the Givetian–Frasnian and that were already present in the Pragian. It is all the more surprising that reefs and stromatoporoids were conspicuously rare in the Pragian.

To some extent, the rarity of reefs and the low diversity of the stromatoporoid fauna in the Lower Devonian can be explained by the fact that their habitats – shallow seas without much sediment input – were reduced in extent at this time, because global sea level was at its lowest for Devonian times during the Pragian and Lower Emsian [17; 18; 19; 20]. But this alone is

not enough to explain fully why reefs and stromatoporoids were so much rarer in the Lower Devonian than in the Middle Devonian. Therefore, this short communication addresses the question of whether Lower Devonian stromatoporoids and reefs were so rare due to ecological factors or whether the causes are to be sought in the evolution of reef-building organisms.

### 2. Investigated reefs

The author studied three stromatoporoid-bearing reefs from the Pragian of western and central Europe. A central point in each case was the specific determination of the stromatoporoid fauna, but rugose corals, tabulate corals and microfacies were also considered to varying extents. In detail, the following occurrences were studied:

- The large reef complex in the Pragian of Koněprusy, a village about 30 km southwest of Prague in the Czech Republic (coordinates: 49° 54' 40" N, 14° 04' 40" E). This reef complex has been studied scientifically for more than a hundred years. For example, the stromatoporoids were first described by Počta [21]. By 1995, about 500 different species of organisms had been described from the Koněprusy reef complex [22, p. 26]. It is worth mentioning that in Koněprusy are also exposed shallow marine limestones of the Eifelian and Lower Givetian, which contain stromatoporoids and corals. In this way, a direct comparison of the reef-builders is possible. The results of the author's research were published by May and Ernst [23; 24; 25].

- The “Hohe Warte Formation” at Mount Seewarte in the central Carnic Alps in Austria, close to the border with Italy (coordinates: 46° 36' 31" N, 12° 52' 15" E). These limestones comprise the Pragian and extend into the lowermost Emsian. They contain reef structures built up from stromatoporoids and corals. Information on fauna and microfacies is provided by May and Pohler [26; 27; 28].



- The locality Zújar about 35 km south-easterly of Zalamea de la Serena (Southern Spain) (coordinates: 38° 29' 30" N, 1° 46' W). Outcropping are siliciclastic sediments and limestones of Lochkovian, Pragian and Famennian age. Brachiopods and conodonts prove that the limestones with corals and stromatoporoids are Pragian in age [29; 30]. The stromatoporoids and rugose corals are described by May and Rodríguez [16].

Mount Seewarte is about 400 km from Koněprusy and the locality Zújar is about 2000 km from Koněprusy and about 1700 km from Mount Seewarte. Nevertheless, there are faunistic similarities between Koněprusy and the other two localities. At Mount Seewarte, the stromatoporoid *Plectostroma latens* (Počta, 1894) is common, which had previously only been known from the Pragium of Koněprusy. In addition, the two tabulate corals *Helioplasma* aff. *aliena* Galle, 1973 and *Scoliopora* (*Protoscoliopora*) *puberulus* (Janet in Dubatolov et al., 1968), which have very closely related species in the Pragium of Koněprusy, are found at Mount Seewarte [28, p. 288]. At the locality Zújar, the two rugose corals *Joachimastrea barrandei* Galle, Hladil and May, 1999 and *Rhizophyllum* ex gr. *bohemicum* Počta, 1902 as well as the tabulate coral *Remesia koneprusiana* Galle, Hladil and May, 1999 are found, which had previously only been known from the Pragium of Koněprusy [16, p. 230; 31, p. 84–85; 32].

### 3. Discussion

The observations made at these three localities lead to three possible explanations for the fact that reefs and stromatoporoids were much rarer in the Pragian than in the Givetian–Frasnian:

1) The water temperature in the Pragian was very different from that in the Givetian–Frasnian.

2) Important elements of the Middle Devonian stromatoporoid fauna were missing in the Pragian, or the evolution of the corresponding elements of the stromatoporoid fauna had not yet progressed far enough.

3) The evolution of the *Syringopora* commensalism was necessary.

### 3.1. Very different water temperature

The Pragian reefs show peculiarities in the composition of the reef-builders, which indicate that a relevant environmental factor, which cannot be read off easily from the sedimentation conditions, was different between the Pragian and the Givetian–Frasnian. When considering this environmental factor, one must first and foremost think of water temperature. These features are:

- Stromatoporoids are only subordinate reef builders in the Koněprusy reef, whereas they are the dominant reef builders in the Middle to Upper Devonian reefs.

- Incrusting bryozoans are very common in the Koněprusy reef. In the Middle to Upper Devonian reefs, however, they are extremely rare. Apparently, the incrusting bryozoans in the Koněprusy reef take over the role of the incrusting stromatoporoids.

- The solenoporaceans are very common in the Koněprusy reef, whereas they are usually extremely rare in the Middle to Upper Devonian stromatoporoid reefs. Only in rare cases [33, p. 545] solenoporaceans are important framework builders in places in Middle to Upper Devonian reefs.

- The high abundance of the calcimicrobe *Renalcis granosus* Vologdin, 1932 in the Koněprusy reef is remarkable. *Renalcis granosus* Vologdin, 1932 also occurs in the Pragian reefs at Mount Seewarte (Fig. 1). Late Devonian limestones are described from Canada with a high amount of microbial carbonates and *Renalcis*, what is interpreted as indicators of environmental change and biotic crises in carbonate systems [34].

- Similarly, algal and microbial communities dominate in the Lower Devonian reef structures of the Urals [4] and Saudi Arabia [5].

- At Mount Seewarte, the reefs are stromatoporoid-hydrozoan buildups. Here the problematic hydrozoan *Fistulella undosa* Shuysky, 1973 is very common and acts as binder and encruster in the reef community (Fig. 2) [27].

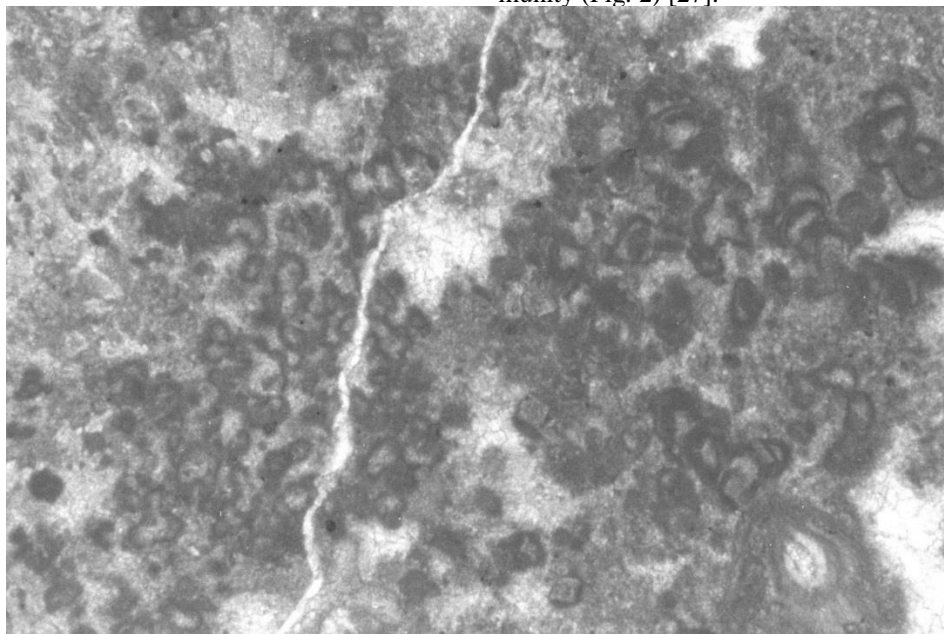


Fig. 1: The calcimicrobe *Renalcis granosus* Vologdin, 1932 from the Pragian of Mount Seewarte (Austria).

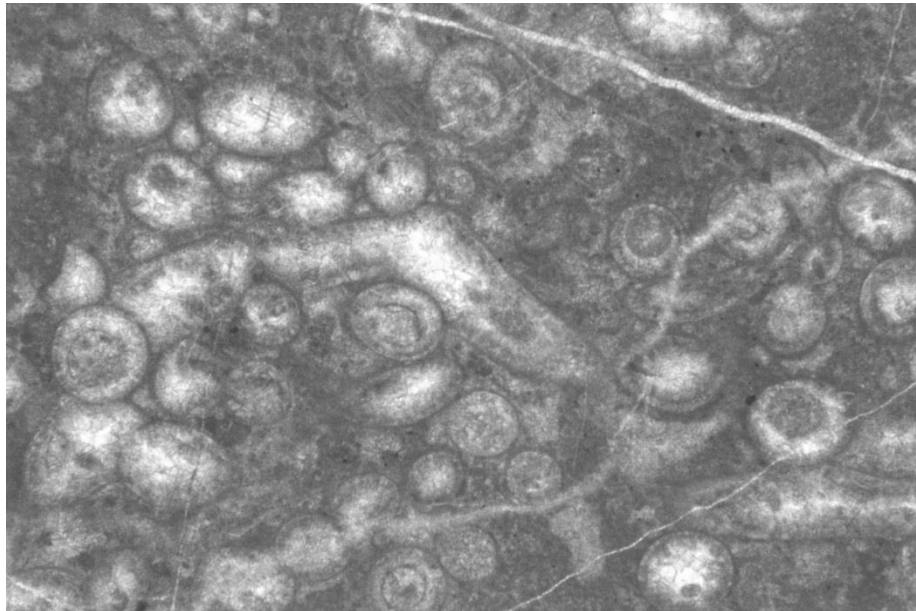


Fig. 2: The problematic hydrozoan *Fistulella undosa* Shuysky, 1973 from the Pragian of Mount Seewarte (Austria).

Now, the question is whether the water temperature in the Pragian was lower or higher than in the Givetian–Frasnian. Arguments for lower water temperatures are:

- Global sea level had its low for the Devonian period during the Pragian and Lower Emsian [17; 18; 19; 20]. This resulted in a maximum size of the dry land fraction. This in turn led, on the one hand, to a particularly large albedo of the Earth [13, p. 43; 35; 36, p. 58] and, on the other hand, to particularly large climate contrasts on the Earth. Accordingly, Boucot [37] and May [13] assume that in the Lower Devonian the climate worldwide was significantly cooler and the temperature gradient from the equator to the poles considerably greater than in the Givetian–Frasnian.

- Hladíková et al. [38, p. 239–240; 39] found that the delta-18-O values of the Pragian, Emsian and Lower Eifelian micritic limestones of Bohemia were strikingly high, but had decreased in the Upper Eifelian to values normal for Devonian carbonates. They explained this phenomenon by hypothetical barriers that hindered water exchange between Bohemia and the open ocean during this time [38]. However, this high delta-18-O values can also be explained very well by a lower water temperature [39; Hladil, oral comm.].

In contrast, modern investigations speak for strongly increased water temperatures:

- By analysing oxygen isotopes in apatite, Joachimski et al. [40] come to the conclusion that temperatures were high in the Lochkovian and Pragian, as high as they were again from the upper Frasnian onwards.

- Based on investigations in the Spanish Central Pyrenees, Slavík et al. [41] state that the essential parts of the Pragian were still a “hot and humid” period, even with the strong differences from the possibly “extremely hot” Lochkovian.

### 3.2. Differences in the stromatoporoid fauna

The second hypothesis is that the stromatoporoids, as the most important reef-building group of the Middle Palaeozoic reef era [11], had a low point in their evolutionary history during the Pragian and at this time the reef-building ability of the group was limited. This is supported by the following observations:

- Both in the large reef complex in the Pragian of Koněprusy and at Mount Seewarte in the Pragian, branching stromatoporoids are completely absent. Only at locality Zújar were sporadic *Amphipora* sp. Globally, throughout the Lower Devonian, branching stromatoporoids were rare and poorly diverse. However, they played a central role in Middle to Upper Devonian reef complexes [42; 43; 44; 45; 46; 47]. In Bohemia, this group is already found in the *Acanthopyge* limestone of the Eifelian with the two most important genera (*Amphipora* and *Stachyodes*) [24, p. 129–130].



Fig. 3: The thinly incrusting stromatoporoid *Syringostromella columnaris* (Počta, 1894) from the Pragian of Koněprusy (Czech Republic) (vertical thin section).

- Thinly encrusting stromatoporoids – typically species of the genus *Clathrocoilona* – were very common in Middle to Upper Devonian reef complexes [43; 44; 47; 48; 49]. In contrast, thinly encrusting stromatoporoids were very rare in the Pragian: At the locality Zújar and at Mount Seewarte they are completely absent and in Koněprusy they are very rare.

The only thinly incrusting stromatoporoid in the Pragian of Koněprusy is *Syringostromella columnaris* (Počta, 1894) (Fig. 3). However, *S. columnaris* was the only *Syringostromella* species to develop a thin-layered incrusting growth form; even *S. zintchenkovi* (Khalifina, 1960), which occurs from the Lochkovian to the Emsian and probably differs from *S. columnaris* only on a subspecific level, does not have a thin-layered incrusting growth form [24, p. 200]. Instead, incrusting bryozoans were very important in the Pragian Koněprusy reef complex.

Apparently, the great rarity of thinly encrusting stromatoporoids in the Pragian is related to the fact that no stromatoporoid group was well adapted to this ecological niche. Species of the genus *Clathrocoilona*, which were well adapted to this ecological niche and represented the most important thinly encrusting stromatoporoids of the Middle to Upper Devonian reefs, appeared only later – in Bohemia the first records of *Clathrocoilona* are from the middle Eifelian [24, p. 182].

- In the Pragian of Koněprusy, species of the order Stromatoporellida were rare and exclusively restricted to the reef core. The rarity of Stromatoporellida in the Koněprusy reef is not a phenomenon restricted to Bohemia. No Stromatoporellida at all are known from Mount Seewarte. At the locality Zújar, a total of two colonies of Stromatoporellida were found, which could

be identified as *Stictostroma gorriense* Stearn, 1995 and *Stictostroma nunavutense* Prosh and Stearn, 1996. Both species had their oldest occurrence to date in the Lower Emsian of Arctic Canada [50]. The relevant literature [7; 8; 9; 51; 52] consistently shows that the Stromatoporellida in the Pragian were only at the beginning of their evolution. This is reflected in both the diversity and ecological range of habitats colonised by Stromatoporellida. The increase in abundance, diversity and conquest of habitats went hand in hand for the Stromatoporellida and enabled their flourishing in the Middle to Upper Devonian. In the Middle Devonian and Frasnian, the Stromatoporellida in particular were also common and widespread outside the reef cores [24, p. 129–130; 42; 43; 47; 48; 53].

- The four most common stromatoporoids of the central reef area of Koněprusy are endemic species: *Parallelopora florida* (Počta, 1894) represents 30% of the stromatoporoids of the central reef area of Koněprusy, *Plectostroma latens* (Počta, 1894) represents 16% and the above-mentioned *Syringostromella columnaris* (Počta, 1894) and *Schistodictyon neglectum* (Počta 1894) each represent 8.6% of the stromatoporoids of the central reef area of Koněprusy. All four species have, on the one hand, a very pronounced maximum abundance in the reef core area and, on the other hand, are not known from anywhere else in the world. There is only one exception: *Plectostroma latens* (Počta, 1894) was also found on Mount Seewarte, where it is the most common stromatoporoid. This suggests that these four species were specifically adapted to the reef complex of Koněprusy. Apparently, the stromatoporoid fauna of the Pragian lacked taxa specifically adapted to reefs in general, so that in the Koněprusy reef complex these endemic species

evolved from widespread taxa. It is noteworthy that the bryozoan fauna of the Koněprusy reef also contains numerous endemic species [25].

### 3.3. Evolution of the *Syringopora commensalism*

More or less frequently, commensal organisms are found in stromatoporoids: syringoporid tabulate corals,

rugose corals or worm-like organisms. Some of them are probably true symbioses. An overview is given by Kershaw et al. [54].

In this respect, the stromatoporoids from the Pragian that I studied are clearly different from Middle and Upper Devonian stromatoporoids.

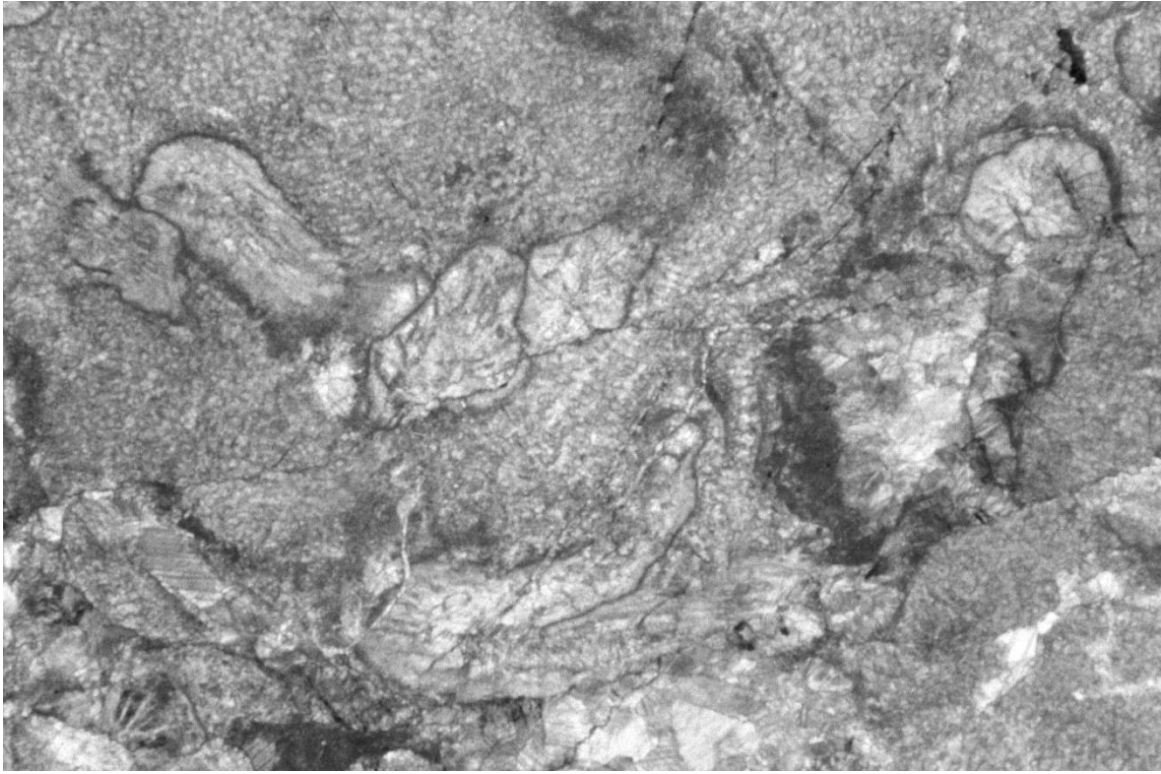


Fig. 4: The rugose coral *Fasciphyllum* as a commensal within the stromatoporoid *Plectostroma latens* (Počta, 1894) from the Pragian of Mount Seewarte (Austria).

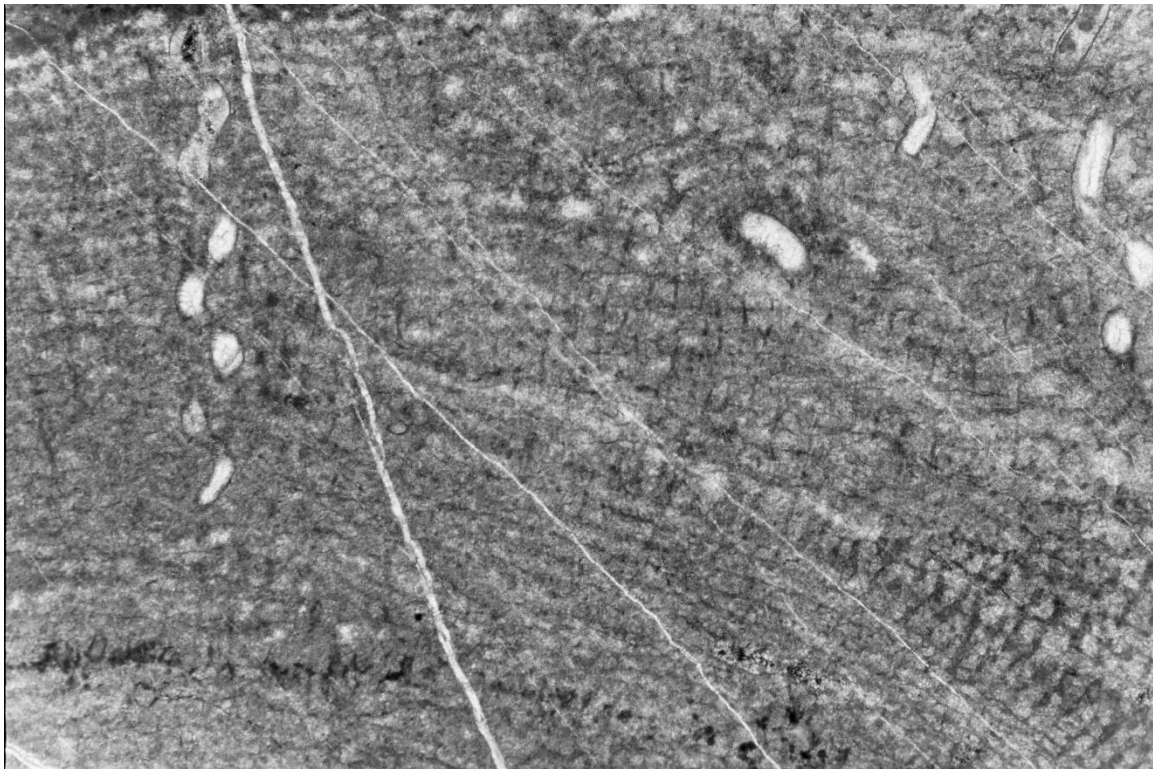


Fig. 5: Tubes of the worm-like commensal *Helicosalpinx* in the stromatoporoid *Plectostroma altum* (Ripper, 1933) from the Pragian of locality Zújar (Southern Spain) (vertical thin section).

At Mount Seewarte, the only commensal organism found in the stromatoporoids was the rugose coral *Fasciphyllum* (Fig. 4). At locality Zújar, the stromatoporoid *Plectostroma altum* (Ripper, 1933) occasionally contains the worm-like commensal *Helicosalpinx* (Fig. 5). In addition, the rugose coral *Loyolophyllum* is found as a commensal in stromatoporoids at locality Zújar. Neither at Mount Seewarte nor at locality Zújar syringoporid tabulate corals were found in the stromatoporoids.

30% of the stromatoporoid colonies found in the Pragian of Koněprusy show tubes of worm-like commensal organisms. But only 8% of the stromatoporoid colonies found in the Pragian of Koněprusy contain syringoporid tabulate commensals. May [24, p. 224–225] described these syringoporid tabulates under the name *Syringopora praeahanshanensis* May, 2005. *S. praeahanshanensis* has great similarities to the commensal *Syringopora* species widely distributed in the Middle Devonian. In the Middle Devonian *Syringopora* species, formerly called “*Caunopora*”, the tubular corallites run more or less long distances parallel to the vertical skeletal elements of the stromatoporoid [24, p. 223–226; 55, p. 204–210]. But in *S. praeahanshanensis* May, 2005 from the Pragian of Koněprusy, the tubular corallites do not run long distances parallel to the vertical skeletal elements of the stromatoporoid. Moreover, in *S. praeahanshanensis* the colonies of the commensal *Syringopora* are quite small, and it can be seen that the *Syringopora* grew together with the stromatoporoid for only a relatively short time. Therefore, it is assumed that the *Syringopora* commensalism observed in the Pragian of Koněprusy is the primitive initial stage of the Middle Devonian “*Caunopora*” commensalism [24, p. 222].

In the stromatoporoids of the *Acanthopyge* limestone of the Eifelian and Lower Givetian of Koněprusy, commensalism with *Syringopora* is very widespread. 32 % of the bulbous to layered stromatoporoids of the *Acanthopyge* limestone contain *Syringopora* commensals. The *Syringopora* species here always have the typical character of “*Caunopora*” tubes and their tubular corallites run long distances parallel to the vertical skeletal elements of the stromatoporoid. In the stromatoporoids of the *Acanthopyge* limestone of the Eifelian and Lower Givetian there are no tubes of worm-like commensal organisms, but occasionally the rugose coral *Fasciphyllum* is found as a commensal. This picture is typical for the Middle Devonian: In the stromatoporoids, *Syringopora* commensals are frequently found, occasionally commensal rugose corals and only rarely tubes of worm-like commensal organisms [55; 56].

In connection with the Devonian *Syringopora* commensalism, it must be mentioned that commensal *Syringopora* species were already present in stromatoporoids during the Silurian. These commensal *Syringopora* species are common in the Middle and Upper Silurian and have the typical character of “*Caunopora*” tubes, because their tubular corallites run long distances parallel to the vertical skeletal elements of the stromatoporoid. Illustrations and descriptions can be found in

various publications [54, p. 69–73; 57, p. 52–54; 58, p. 102–104; 59; 60; 61; 62].

Thus, it can be seen that in the Silurian and Devonian periods with frequent stromatoporoid reefs, *Syringopora* commensalism was widespread in the stromatoporoids and the *Syringopora* had the typical character of “*Caunopora*” tubes, as their tubular corallites run long distances parallel to the vertical skeletal elements of the stromatoporoids. In the Pragian, the reverse is true: stromatoporoid reefs were very rare, *Syringopora* commensalism was very rare, and *Syringopora* commensals grew together with the stromatoporoid for only a relatively short time. This evidence suggests that the *Syringopora* commensals were beneficial to the stromatoporoid – that it was therefore a true symbiosis – and that the *Syringopora* commensals increased the reef-building potential of the stromatoporoid. Vinn [63, p. 147] assumes that calcareous rigid skeletons of syringoporids may have reinforced skeletons of stromatoporoids.

I suspect that the Devonian *Syringopora* commensalism is not the direct successor of the Silurian *Syringopora* commensalism, but that the Silurian *Syringopora* commensal species disappeared in the uppermost Silurian or deepest Devonian. Then, in the Pragian, another *Syringopora* species began to reinvent commensalism with stromatoporoids and evolved into *Syringopora praeahanshanensis* May, 2005. *Syringopora praeahanshanensis* May, 2005 from the Koněprusy Limestone bears very close resemblance to *Syringopora hanshanensis* Chow, 1980, from which it differs only in details of growth habit. However, *S. hanshanensis* is the first *Syringopora* species which shows the typical Middle Devonian “*Caunopora*” commensalism. Moreover, *S. hanshanensis* is the most common *Syringopora* species in the Eifelian, and the other Devonian commensal *Syringopora* species can be derived from it, as shown by the studies carried out by May [24, p. 221–226]. The step from the primitive initial stage of *Syringopora* commensalism in *S. praeahanshanensis* May, 2005 to typical “*Caunopora*” commensalism must have occurred at about the time of the Pragian/Emsian boundary; because the holotype of *S. hanshanensis* showing typical “*Caunopora*” commensalism dates from the Lower Emsian [64, p. 131].

#### 4. Conclusions

There are several possible reasons for the extreme rarity of reefs in the Pragian. One is water temperatures that were not conducive to the growth of stromatoporoid reefs. Another important reason was that stromatoporoid groups, which were of central importance in the Givetian and Frasnian reefs, were only at the beginning of their evolution and expansion in the Pragian. And finally, to all appearances, there was a break in the *Syringopora* commensalism of the stromatoporoids in the uppermost Silurian or deepest Devonian. In the Pragian, Devonian *Syringopora* commensalism began again with the primitive initial stage of *Syringopora praeahanshanensis* May, 2005. Which of these factors played which role cannot be judged at present. Presumably, all factors acted together. In order to better understand the interrelationships, it will be necessary to extend these investigations to other Pragian reefs and to

include reefs of the uppermost Silurian and deepest Devonian.

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# MEDICAL SCIENCES

## CLINICAL AND DYNAMIC CHARACTERISTICS OF PERSONALITY DISORDERS IN PERSONS WHO HAVE COMMITTED SOCIALLY DANGEROUS ACTS

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### ABSTRACT

The article discusses the results of a study of the clinical and dynamic characteristics of personality disorders in persons who have committed socially dangerous acts; a clinical, dynamic and socio-psychological analysis of the factors that determine the aggressive criminal behavior of subjects with personality disorders is carried out.

**Keywords:** personality disorders, socially dangerous act, aggressive behavior.

**Introduction.** Socially dangerous actions of persons with mental disorders remain one of the important problems of general and forensic psychiatry. Two main aspects can be distinguished in this problem – the allocation of clinical criteria for forensic psychiatric assessments of mental disorders in defendants who have committed aggressive acts, and the recommendation to prescribe coercive medical measures. In the forensic psychiatric assessment of certain mental disorders and the justification of compulsory medical measures, it is necessary to take into account the psychopathological, psychological, motivational, situational and social factors that influence the socially dangerous behavior of the subject [3, 5]. Forensic psychiatric examination of persons with mental disorders who have committed unlawful acts also requires taking into account such important parameters as “aggression” and “aggressiveness”, their connection with the current mental state.

The problem of aggression, in general, has long been studied in the following aspects: the definition of the concepts of “aggression”, “aggressiveness”, the systematics of individual forms of aggressive behavior. The most important and topical issue is the assessment of the conditionality of aggression by mental pathology. This fully applies to the study of aggression in subjects with personality disorders. A direct link between aggressive criminal acts and personality disorders was pointed out by many authors [4, 6, 8].

Of particular importance to the problem of aggressive behavior of subjects with personality pathology is given in a forensic psychiatric clinic, where this disorder occurs quite often. During the forensic psychiatric examination of subjects with personality pathology accused of committing aggressive criminal acts, in addition to studying the structure, depth and dynamics of personality disorder, great importance is attached to the motivation of illegal actions, the influence of social factors. The study of the criminal behavior of subjects with personality disorders also shows the high importance of the psychological component of the analysis of the behavior of subjects during the period related to the acts they are charged with [7, 9, 10]. This is especially important in the forensic psychiatric assessment of mental disorders that limit the ability to realize the actual nature and social danger of their actions or to control

them. An urgent problem also seems to be the determination of the degree of public danger required when recommending coercive medical measures, which are part of the prevention of repeated aggressive criminal acts.

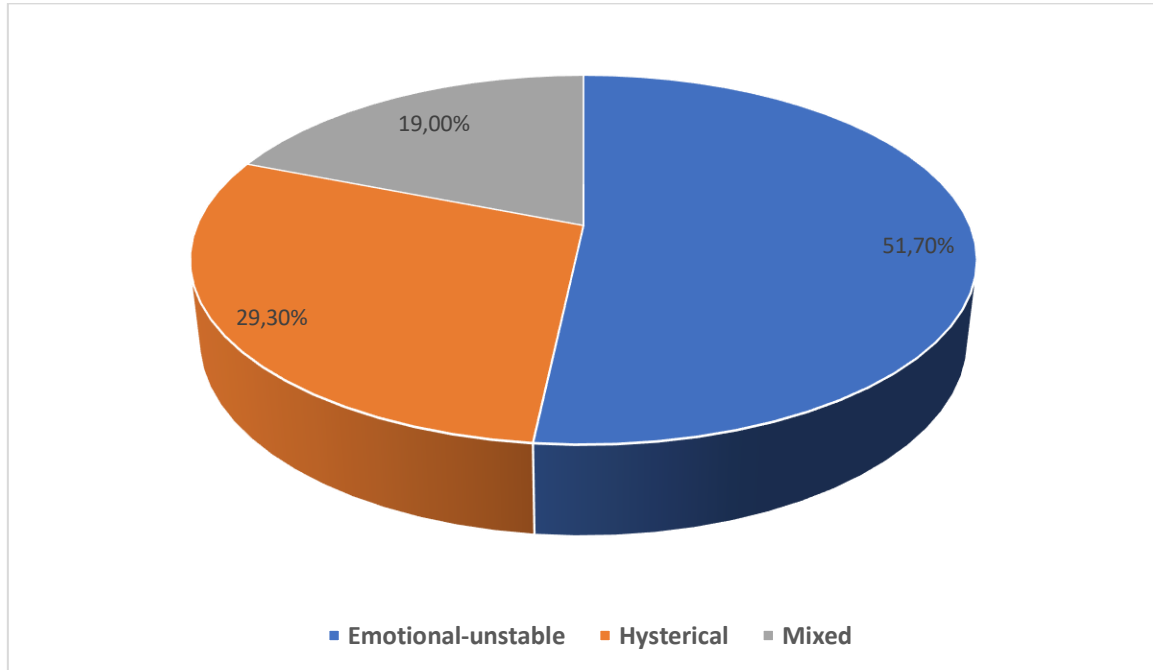
Thus, the forensic psychiatric significance of personality disorders in the examination of the accused is realized in three main aspects: - clinical and diagnostic (determining the depth of personality disorders, ascertaining dynamic shifts); criminological (mainly when assessing a personality disorder as a prerequisite for committing certain illegal acts); expert (forensic psychiatric assessment of personality disorders and recommendation for the appointment of compulsory medical measures).

In recent years, criteria for forensic psychiatric assessments of personality disorders have been intensively developed [1, 2]. At the same time, it should be pointed out that generalized studies of socially dangerous acts committed by persons with various types of personality disorders were not carried out, a forensic psychiatric assessment of personality disorders was not developed, issues of determining social danger were not developed, which is necessary, in particular, when recommending outpatient forced observation and treatment by a psychiatrist. The foregoing determines the relevance of this study.

**The purpose of the study** is to study the clinical and dynamic characteristics of personality disorders in persons who have committed socially dangerous acts.

**Material and research methods.** The study examined 58 men with personality disorders who committed socially dangerous acts. The main research methods were clinical-psychopathological and statistical, as well as experimental-psychological, sexological, paraclinical. Statistical processing included an assessment of the frequency of the analyzed features – absolute value, percentage share, as well as the reliability of the studied features (p index) and their relationship (correlation – R index).

**Research results.** In typological terms, the study group was represented mainly by persons with emotionally unstable personality disorder (30 people – 51.7%), hysterical personality disorder (17 people – 29.3%) and 11 (19.0%) – mixed personality disorders (Fig 1).



*Fig.1. The contingent of examined patients*

Analysis of socio-demographic data showed that the majority of the study group had a low level of education. Many could not adapt to the conditions of military service and labor activity. Their family adaptation was disturbed, intra-family relations were conflicting. At the same time. They adapted quite well in specific subcultures, in particular, criminal ones. This position is confirmed by criminological data. The surveyed had earlier and more frequent prosecutions. The study of the features of the formation of personality pathology showed that 33 (56.9%) individuals had a history of hereditary burden with a predominance of alcoholism and drug addiction (21 people – 36.2%) over other mental pathology.

An analysis of the characteristics of the upbringing of the surveyed showed that the surveyed were significantly more often brought up in conditions of hypocustody, neglect, rejection by their parents, were subjected to physical punishment, humiliation. Relationships with peers in childhood and adolescence can be characterized as equal, partnership, or they occupied a leading position.

Psychopathologically aggravated heredity, pathology of the early period of development, unfavorable social conditions of upbringing and development contributed to the appearance of frequent pathocharacterological reactions in childhood and puberty. During such periods, the subjects showed aggressive behavior, they left school, wandered, and used psychoactive substances. Further aggravation of pathocharacterological reactions formed personality disorders.

In 18 surveyed (31.0%), aggressive and auto-aggressive forms of reaction took place since childhood, which manifested themselves in increased irritability, pugnacity, loudness, cruelty to animals, self-harm, which may be due to a low level of socialization and approval of aggressive forms of behavior. Microenvironment.

The surveyed noted increased sensitivity to external influences, psychological stress and internal biological changes in the body that occurred throughout life. These factors changed the clinical picture of personality disorders. There was a temporary sharpening of character traits, or there were long-term reactions and personality development. Such changes in the state of psychopathic personalities are known as the dynamics of personality disorders, which are characterized by states of compensation and decompensation. Among decompensations, there are acutely emerging states of sharpening of personality traits – characterological (psychopathic) reactions – and a relatively long-term personality development (paranoid development). The states of decompensation were the reason for the primary diagnosis in the examined personality disorders.

Dynamic shifts in the examined persons arose in objectively and subjectively significant psychotraumatic situations in the form of characterological reactions. Such reactions were characterized by an increase in the main pathological manifestations of personality pathology, the appearance of anxiety and affective tension within the limits of the personality's resources. Usually psychopathic reactions were short-term, lasting from several hours to several days. In the development of dynamic shifts, changes in the clinical picture of personality disorders and in the implementation of aggressive urges, the use of psychoactive substances was important. It should be noted the high number of people who abuse psychoactive substances (22 people – alcohol, 15 people – other psychoactive substances).

Negative dynamic shifts disrupted the socialization of the subjects and contributed to the development of aggressive criminal behavior. The aggressive crimes committed by the subjects of the first group were predominantly of a property nature. They more often than others committed robberies, robberies, accompanied by threats, physical violence, often killing the victim

(31.0%). In such situations, their actions were especially cruel. Criminal actions were preceded by the use of alcoholic beverages or drugs, which facilitated the onset of aggression. They often committed planned crimes in a group of people, acting as a leader.

**Conclusion.** Thus, aggressive illegal behavior is characteristic of persons, mainly with emotionally unstable, hysterical and mixed personality disorders (excitable, hypersthenic types). Aggression as a personality trait is formed in childhood and adolescence against the background of adverse factors (mainly microsocial and psychological) and exacerbates the dynamics of personality disorder. Clinical-dynamic and socio-psychological analysis revealed factors that determine the aggressive criminal behavior of subjects with personality disorders: improper upbringing and unfavorable psychotraumatic environment in a family with child abuse; substance abuse; repeated criminal acts in history; acute and chronic traumatic situations preceding the aggressive delict, negative dynamic shifts.

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## METHOD OF DIRECT PROSTHETICS IN PATIENTS WITH GENERALIZED PERIODONTITIS

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### ABSTRACT

Indices of hygiene, gingival bleeding and RMA are significantly better in patients with proposed direct prosthetics in the long term after prosthetics compared with the period before treatment and in the group of patients in whom direct prosthetics were not used. Conclusions. the design of a direct fixed aesthetic prosthesis has advantages over other methods of orthopedic treatment of patients with generalized periodontitis of the II degree of development.

**Keywords:** generalized periodontitis, direct prosthetics, bone tissue atrophy, hygiene indices, bleeding gums.

**Purpose:** to increase the effectiveness of complex treatment of patients with partial loss of teeth and generalized periodontitis by using the proposed method of direct prosthetics.

The main problem of dentistry is the search for new methods for the prevention and treatment of periodontal tissue diseases. According to WHO, periodontal disease is the leading dental disease. Damage to periodontal tissues is accompanied by complex and profound disorders of biochemical, immunological, endocrine metabolic processes [1, 2]. This, in turn, leads to neurovascular disorders in periodontal tissues, causing changes in bone metabolism and metabolic processes of the entire periodontal tissue complex, the development of pathological tooth mobility and their loss. At the same time, the function of chewing is disturbed, areas of traumatic occlusion are created, and defects in the dentition occur [3,4]. Such a clinic requires complex treatment of patients, which includes therapeutic, surgical and orthopedic methods of treatment, pressure on the entire tissue complex affected by the pathological process. Removal of increased deformity to go to the preserved periodontal tissues in the process of chewing is a therapeutic factor and it can be done only with the help of orthopedic methods [5]. Of particular importance are orthopedic methods of treatment in case of partial absence of teeth, combined with generalized periodontitis, which makes it possible to prevent overload of preserved teeth. Significant importance in the treatment of patients with generalized periodontitis, complicated by partial loss of teeth, acquires direct prosthetics. Waiting tactics after the extraction of several teeth leads to an additional overload of the preserved teeth, which in turn causes an exacerbation of inflammatory processes, an increase in the pathological mobility of the teeth, and leads to their removal [6, 7, 8]. Therefore, in generalized periodontitis, the method of direct prosthetics with structures is important, the use of which will prevent the development of complications of the course of generalized periodontitis with partial loss of teeth, the process of atrophy of the bone tissue of the alveolar process after the removal of several teeth due to complications of generalized periodontitis.

We examined 108 people over 45 years old with II-III degree HP, in which the course of the disease was accompanied by partial loss of teeth. Depending on the method of orthopedic treatment, the patients were divided into groups: Group I - 31 patients who, immediately after tooth extraction, had a direct plastic partial lamellar removable im-diat-prosthesis placed on the preserved dentition along with their selective grinding; Group II - 39 patients who underwent conventional permanent prosthetics with fixed bridges 6 weeks after the removal of mobile teeth and wound healing; Group III - 38 patients who, after the removal of mobile teeth, were given a direct fixed, collapsible bridge prosthesis. Along with selective grinding, permanent prosthetics were carried out after 6 months. The control group consisted of 26 people with intact dentition. Studies of the state of the periodontium were carried out using the periodontal index, hygiene indices (IG-DI-S), (IG-SI-S), PMA, gum bleeding, the degree of tooth mobility and

the X-ray recession index, the combined periodontal index KPI were determined. The structural and functional state of the bone tissue was determined by the level of markers of bone tissue metabolism, the mineral density of the bone tissue of the alveolar process in the area of the interdental septa of the preserved teeth was determined using computed tomography. Studies of periodontal tissues were carried out before the removal of mobile and 6 weeks later, as well as 6 months and a year after permanent prosthetics.

#### Research results

A detailed analysis of the indexes of hygiene, bleeding of the gums, the state of periodontal inflammation in patients of three groups was carried out. 6 weeks after removal, they slightly improved in group I, the worst indicator was in group II and in group III of patients.

6 months after prosthetics, the indicators in groups I and II were at the level of  $1.82 \pm 0.05$  and  $1.81 \pm 0.04$  points, and in group III the hygiene index was  $1.42 \pm 0.02$  points. A year after prosthetics, IG-DI-S was  $2.03 \pm 0.06$  points in group I patients, the worst indicator was in patients of group II who did not have direct prosthetics -  $2.23 \pm 0.05$  points, and this indicator was the best in patients of group III, who used a direct non-removable aesthetic prosthesis -  $1.53 \pm 0.05$  points.

6 months after prosthetics, the indicators in groups I and II were at the level of  $1.03 \pm 0.13$  and  $1.08 \pm 0.14$  points, and in group III the hygiene index was  $0.74 \pm 0.15$  points. A year after the orthopedic treatment, IG-SI-S in group I was

patients  $1.29 \pm 0.17$  points, in patients of group II, who did not use direct prosthetics, it was

$1.19 \pm 0.16$  points, and the best indicator was in patients of group III, who used a direct non-removable aesthetic prosthesis -  $0.79 \pm 0.16$  points. Therefore, when analyzing the studied indicators of the periodontal condition in patients of three groups, we established significantly better indicators when using the design of a fixed aesthetic direct prosthesis, stabilization of the pathological process in periodontal tissues in the near and long term, improved oral hygiene and no progression of atrophy.

#### Conclusions

On the basis of clinical indicators, we found that the use of a direct non-removable aesthetic prosthesis design has advantages over other methods of orthopedic treatment of patients with generalized periodontitis of the 2nd degree of development. Indices of hygiene, bleeding gums and RMA are significantly preferable in patients with proposed direct prosthetics in the long term after prosthetics compared with the period before treatment and in the group of patients who did not receive direct prosthetic

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## CLINICAL METHOD FOR THE RESTORATION OF DAMAGED NON-REMOVABLE METAL-PLASTIC PROSTHETIC SPLINTS

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### ABSTRACT

The article describes the options for non-removable splinting using orthopedic structures for periodontal disease. The characteristics of tires, their advantages and disadvantages are given. The problems of periodontology in terms of overloading the abutment teeth with orthopedic structures and the moments of solving this with the help of orthopedic metal-plastic splints and removable dentures are outlined, and the clinical methodology for repairing (restoration) of damaged metal-plastic splints-prostheses is described in detail.

**Keywords:** periodontitis, tires, metal-plastic construction.

The use of splinting at the first signs of pathological tooth mobility is an integral component of the orthopedic treatment of this pathology [1]. All these are mainly manifestations of localized or generalized periodontitis [2], one of the serious diseases of the dentition. For fixed splinting, both stamped crowns and solid structures are used [5]. There are splinting structures using Polyglas tape [3, 4]. Stamped structures carry with them the absence of a cosmetic component, which is currently unacceptable. Purely cast crowns require hard tooth preparation and are very heavy, which does not contribute to effective complex orthopedic treatment of periodontitis. Metal-ceramic and metal-plastic-mass splinting structures have proven themselves better. They are much lighter than non-combined one-piece cast structures. Constructions made of cermet have proven themselves aesthetically well. But, taking into account the properties of cermets, with an antagonizing moment, "hard hits" are obtained. This does not help to alleviate the "provoked" periodontium. A metal-plastic construction is one of the few successful designs for aesthetic periodontal treatment by splinting. These structures are not heavy, and although the plastic has the ability to absorb oral fluid over time, they have a

softer contact antagonizing threshold, which is beneficial for the periodontium in the stabilization stage. Very often, with a fixed bite height in the frontal area and the absence of antagonistic teeth in lateral with orthognathic bite, the frame of the metal-plastic prosthesis on the lower jaw is exposed. This is due to the fact that patients refuse to use a removable prosthesis, and implantation in this case is not indicated or is too financially burdensome for the patient.

At the same time, the provoked periodontium receives an additional load, holding the full power of the dentoalveolar system. Usually, in this case, it is recommended to remove the metal-plastic prosthesis and make a new one, followed by unloading the dentition and manufacturing a removable structure. Removing the prosthesis is a laborious procedure, and re-manufacturing is expensive for the patient and does not spare the load on the periodontium. We offer a method for clinical restoration of the structure without it cutting (removal). We recommend doing this as follows. With the help of the silicone mass, we obtain an impression for the working model, and with the help of the alginate mass, for the auxiliary one. After that, the resulting models are plastered in an occluder, and the height of

the central occlusion determined in the clinic is fixed. The lost height of the crowns is modeled on the model with wax. They are brought into contact with the antagonist teeth, and the model is duplicated. A silicone combined impression is taken from the duplicated model. Further, in the clinic, a metal-plastic structure to be restored in the oral cavity is treated with honey, dried, treated with a monomer, freeing from self-hardening plastic, after which the color of the plastic is determined. Synma-M plastic powder of a given color is mixed with a monomer, freeing it from self-hardening plastic, and filling it with areas that require restoration in the print. After that, the impression is set in place in the oral cavity. After waiting 7–10 minutes, the spoon is removed from the impression and deforming the impression, the metal-plastic crowns restored with plastic are released, after which they are processed, ground and polished in the oral cavity. The patient is given recommendations on the care of metal-plastic crowns. Four patients with this pathology were observed in the clinic over a 2-year period. A delayed examination of each of them was carried out. At a repeated visual examination after six months, the boundary between the new and old plastic was not determined, there were no color changes and breaks, no chips. Based on this, we recommend using this technique in typical cases when using splint

structures in orthopedic treatment of periodontal diseases. In this case, when restoring the structure, a sparing attitude towards the periodontium and the financial situation of the patient is determined.

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## PHONETIC PARTICIPATION OF THE PATIENT IN THE MANUFACTURE OF COMPLETE REMOVABLE LAMELLAR DENTURES

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### ABSTRACT

Active phonetic participation of the patient in the manufacture of prostheses at the stage of checking the setting of artificial teeth on a solid basis and the use of an entropy assessment of the pronunciation of a consonant sound contributes to faster speech adaptation to prostheses in the process of their manufacture.

**Keywords:** complete removable denture, use of phonetics.

To restore high-quality speech function during orthopedic treatment with complete removable laminar prostheses, special importance must be attached to the design of artificial dentitions of a particularly frontal group. Many authors recommend designing artificial dentition in such a way as to reproduce the signs of the chewing apparatus as much as possible. According to a number of researchers [1, 2], ideal occlusal relationships are a theoretical model that is not a biological reality or necessity. When designing artificial dentitions, it is necessary to take into account the peculiarities of the status and individual characteristics of the masticatory apparatus of a patient with a complete absence of

teeth at the time of treatment, anatomical, topographical and functional landmarks. To create sagittal and transversal curves in complete removable lamellar dentures, M.E. Vasiliev, based on the anatomical rules for placing artificial teeth, proposed to design artificial dentitions relative to the glass plane [3]. A number of authors [4] point out that this technique does not always provide good aesthetic and phonetic results, since the frontal groups of artificial teeth of the upper and lower jaws are designed with average anatomical principles and do not always correspond to individual pronunciation features in hard bases. of the oral cavity at the clinical stage of manufacturing a full-removable lamellar prosthesis, during which individual occlusal surfaces

are formed and each patient is individually corrected for speech function by recording and analyzing using the developed computer program WavAnalyzer v1.2 [5].

By checking the pronunciation of sounds, each patient was individually checked whether the design of artificial dentition corresponded to his individual characteristics. In the case of distorted pronunciation of sounds, a correction was made and again controlled until the desired result was achieved. The aim of the work is to increase the effectiveness of orthopedic treatment of patients with complete removable lamellar dentures by improving the method of constructing the frontal group of teeth, taking into account the patterns of speech articulation. 38 (44) people with complete absence of teeth were examined. Of these, 10 (12) people were re-prosthetized and for 28 (32) people full removable laminar dentures were made for the first time. Patients were offered a language task. It consisted in the pronunciation of the syllables "IS" and "ISh" of the Russian language, since the peculiarity of the pronunciation of these syllables is the contact of the lateral surface of the tongue with the palatine tubercles of the lateral teeth and the formation of a gap between the back (sound "S"), tip (sound "Sh") of the tongue and the anterior part of the hard palate with the adjoining part of the cellular process, while forming a narrow gap in the middle through which the air jet breaks out with force between the front teeth, a sharp noise resembling a whistle (non-rhythmic oscillations) occurs. Therefore, the clarity and purity of the pronunciation of the consonant sounds "s" and "Sh" depend on the position of the frontal teeth on the upper and lower basis.

For the analysis, the developed specialized software WavAnalyzer v1.2 was used, which makes it possible to implement the calculation of entropy estimates and comparison operations in automatic mode, followed by the presentation of the results in the form of digital sets that are convenient for graphical representation and processing. The use of entropy characteristics makes it possible to consider the studied sound signal as a probabilistic-temporal sequence, which in turn leads to the formation of representations of various shapes, more suitable for correlation analysis by relatively amplitude-frequency characteristics. To check and correct the pronunciation of sounds at the clinical stages of manufacturing complete removable lamellar dentures, a solid prosthesis base was used, made of a hard elastic plate that meets certain requirements: it had a minimum thickness, is uniform in thickness over the entire surface of the hard palate, durable, not deformable from temperature in the oral cavity, is well fixed in the oral cavity, reproduces the anatomical relief of the hard palate.

The results of the study and their discussion of the 38 people for whom complete removable dentures were made using the improved method, 10 (26.32%) people were re-prosthetized and for 28 (73.68%) people full removable lamellar dentures were made for the first time. At the verification stage designing artificial dentitions, the orthopedic treatment of which was repeated, was  $0.07 \pm 0.006$  and  $0.06 \pm 0.004$ , respectively. They did not need to be corrected, since the entropy value slightly deviated from the direct and subjective value; when assessed by ear, the pronunciation of the test syl-

lables was not very clear with the addition of insignificant noise. Among the 28 patients for whom orthopedic constructions were made for the first time, in 24 people (85.71%) the entropy value "S" and "SH" did not exceed 0.1. In 4 cases (14.29%), the entropy values of the pronunciation of the consonant sounds "S" and "Sh" ranged from 0.12 to 0.33 and from 0.12 to 0.41, respectively. In these individuals, the correction of the design of the frontal group of teeth was carried out, since the deviation from the straight line was quite significant and subjectively the pronunciation of the sounds "C" and "Sh" was complicated and distorted. In particular, the pronunciation of the sound "S" with admixtures of whistling and replacement with the letter "C", and the pronunciation of the sound "Sh" lisping. With the help of a heated spatula, the wax was softened on the upper and lower solid bases and we slightly tilt the frontal upper and lower artificial teeth to the labial or lingual sides, while it is necessary to maintain the gap between the frontal teeth during pronunciation, it characterizes the quality of pronunciation. In addition, depending on the inclination of the artificial teeth, the height of the lower frontal teeth was raised or lowered. When tilted to the labial side, the height of the lower frontal teeth was increased, and when tilted to the lingual side, it was reduced. ( $<0.05$ ). Subjectively, when listening to the sounds "S" and "Sh", there was a slight noise

Active phonetic participation of the patient in the manufacture of prostheses at the stage of checking the installation of artificial teeth on a solid basis and using the entropy assessment of the pronunciation of the consonant sound contributes to faster language adaptation to prostheses in the process of their manufacture. The patient gradually gets used to the pronunciation in the new environment. It is important that the design correction takes place in the presence of a doctor. Such a phonetically controlled defect-free pronunciation during the construction of the prosthesis prevents patients from developing incorrect speech skills and reduces the period of adaptation to removable structures.

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# PEDAGOGICAL SCIENCES

## APPLICATION OF THE METHOD "DIDACTICAL CINQUAIN" IN THE TEACHING OF THE SUBJECT "CHILDREN AND TEENAGE LITERATURE"

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### ABSTRACT

This paper presents the technology of application of the Didactic Cinquain method, the results achieved, and outlines the perspectives for its future application. The method was implemented with undergraduates of the specialty "Bulgarian Language and History" from the University of Ruse and Vidin Branch, who are studying the discipline "Children and Teenage Literature".

**Keywords:** Didactic cinquain, Course "Children and Teenage Literature", Bachelors, higher education, creative task.

### Introduction

The poetic form *cinquain* (French *cinquain*, English *cinquain*) originated in the early 20th century in the USA. Its creator was the American poet Adelaide Crapsey (1878–1914), who was influenced by Japanese short-form poetry *haiku* and *tanka* and created an original genre [1]. In its original form, the poem consists of five unrhymed stanzas that form a poetic unity. Formally, the cinquain consists of 22 syllables and has the following pyramidal structure of syllables: 2-4-6-8-2.

In the following decades, the poetic form of *the cinquain* became an educational method. The methodology was developed in the USA and is known as *didactic cinquain*. Only the idea of a stanza of five lines has remained of the original conception of the poetic form. The model of didactic cinquain looks as follows:

*First verse* (the subject of the cinquain): a noun or pronoun.

*Second verse*: two words – adjective or participle. They describe the attribute of the selected object.

*Third verse*: three verbs or verbal adverbs describing the characteristic actions of the subject.

*Fourth stanza*: a four-word phrase/ statement expressing the author's personal attitude toward the subject or object being described.

*Fifth verse*: a distinct noun characterizing the subject (a synonym), also serving as a conclusion. (For more details on the origin of the cinquain, see [2], [3].

### Exposition

Our preliminary studies have shown that didactic cinquain is not widely used in contemporary Bulgarian education, unlike its widespread use in the American and Russian educational systems. It is sporadically used in Bulgarian language teaching at the primary stage of education [4], [5]. Our opinion is that this method has great pre-educational and educational potential and should be applied more often in various subjects at all stages of education, including higher education.

In the academic year 2020–2021, the second-year bachelor students in the specialty "Bulgarian Language and History" from the University of Ruse "Angel Kanchev" and the Vidin Branch, studying in the discipline "Children and Teenage Literature", were offered to create an author's cinquain. 49 undergraduates were involved.

In this paper, we present the technology of the method application, the results achieved, and the outlined perspectives for its further application.

### Technology of application of the method "Didactic cinquain"

*Preliminary preparation*: the teacher prepares a presentation that includes the following components: definition of a cinquain, rules for writing it, examples, the due date for the assignment, ready template<sup>1</sup>, suggestions of topics for creating it, and specifies the criteria for evaluation<sup>2</sup>. Once the assignment is specified, the information is sent to the students so that they can have it at their disposal during their preparation.

It is known that not all learners have an affinity for poetry, the creation of a cinquain is characterised as a *creative task rather* than writing a poem. The presentation of the assignment can be done face-to-face or in the process of synchronous or asynchronous distance learning. In each case, a PowerPoint presentation is created for better visualization.

Different themes are proposed and oriented in two main units.

**Concepts specific to the discipline of *Children and Teenage Literature***: literature, fairy tale, fable, poem, initiation, short story, riddle, legend, myth, magic, animal, bit, child, adolescent, hero, antagonist, giver, sender.

**Common human themes also tied to the discipline**: love, family, home, wisdom, kindness, life, beauty, nature, fate, luck, freedom, and adventure.

<sup>1</sup> The special template was developed for convenience and was borrowed from the American methodology.

<sup>2</sup> Students in the first group are graded on a 6-point scale with a maximum of 15 points and represents an element of their

semester exam. Students in the second group create a synopsis as part of their semester commitments, receive points but they are not included in their overall semester grade.



In implementing the method, we formulated the following didactic and educational tasks.

*Didactic tasks:*

- ✓ Learning, comprehension, and correct application of parts of speech;
- ✓ Developing information synthesis skills;
- ✓ Enriching language culture and improving vocabulary;
- ✓ Developing creativity;
- ✓ Developing critical thinking;
- ✓ Skills to compose a complete (poetic) text.

*Educational tasks:*

- ✓ Comprehension and understanding of the concepts of the discipline;

- ✓ Learning a new didactic method.

**Results**

A total of 53 cinquains were obtained because several learners worked on two different topics of their own volition. The students preferred to write mostly on general human themes, with most texts produced on the themes of *child, freedom* and *love*. Their own themes are also suggested: *car, war, wolf, fairy*. Significantly fewer are the cinquains devoted to the specific concepts of the discipline of *Children and Teenage Literature*: two works on *initiation*, one each on *antagonist, literature, legend* and *hero*. The choice of topics is explicable – since the method is unknown to the learners, they instinctively stick to the more familiar field.

Table 1.

Examples of cinquain creation in the discipline "Children and Teenage Literature"

<p><b>Common human themes also linked to the discipline</b></p>	<p><b>Love</b> Selfless, unique Excites, comforts, inspires When the soul becomes whole Patience</p>
<p><b>Concepts specific to the discipline "Children and Teenage Literature"</b></p>	<p><b>Initiation</b> Symbolic, pagan Separates, dedicates, includes An important ritual for growth and maturation Symbols</p>

As it has become clear, each cinquain is evaluated according to predetermined evaluation criteria. They are as follows. 1. The cinquain is written according to the rules (number of words) – 1-3 points; 2. Content (absence of notional errors and contradictions) – 1-3 points; 3. Literacy (absence of grammatical and punctuation errors); 4. Parts of speech mentioned in the rules are used correctly; 5. Questionnaire completed – 1 point<sup>3</sup>; 6. Originality of performance – 1-2 points.

The introduction of a scoring system for the evaluation of the cinquains excludes subjectivity. The scores obtained are between 10 (the lowest) and 15 (the highest). The highest number of students scored 14 points. 15 points were obtained by 19 learners.

The tutor gives feedback with brief comments, errors, and points formed based on the specified criteria.

Although at first glance the creation of a cinquain seems easy, mistakes have been made, which we will systematize here.

- ✓ Use of template phrases and sentences: *big world; beautiful, big, unexplainable love; easy/ hard life; warm, cozy home*;
- ✓ Inconsistency of the noun (line 1) with the verbs (line 4) – 5 uses;
- ✓ Repetitions – 5 people;
- ✓ Inappropriate combination of words (*cozy family; biological love; colourful fairy, young child*) – 4 people;
- ✓ Inconsistency of the noun (1 line) with the adjectives/participles – 2 uses;
- ✓ Incorrect use of parts of speech (e.g., in line 5 is used the adjective instead of their noun) – 3 people;
- ✓ Grammatical/ spelling errors – 3 people;

- ✓ Vague phrase – 3 people;
- ✓ The phrase does not comprise of four words (it's longer or shorter) – 2 people;
- ✓ Incorrect linking of a noun with a reflexive verb – 2 people;
- ✓ Missing the personal attitude in the phrase – 1 student;
- ✓ Inappropriate use of inversion (*Two hearts captivated* – "Love") – 1 student;
- ✓ Inappropriate choice of synonyms (*literature – bit*, lines 1 – 5) – 1 student;
- ✓ Choice of ungrammatical words – lives – 1 student;
- ✓ Technical errors – 1 student.

As can be seen from the summary list of errors, they are mainly related to the incorrect use of parts of speech and stylistics. However, we can say that the omissions are not many. To a lesser extent, mistakes were made in the exact execution of the instructions for writing the cinquain.

Although the students are not asked to write a poem as a prerequisite, some of them try to demonstrate originality. Here we present some of the more imaginative phrases: *turns the sage into a dreamy fool; like a black and white film; makes the heart happy; when the soul becomes whole* ("Love"), *happiness for the human eye and soul* ("Beauty), *gives meaning and strength to life* ("Beauty); *birth is a mysterious female initiation* ("Initiation); *gave the bird freedom* ("Freedom").

Generally as a good poem I rate the cinquain of a student from Vidin Branch: the text is executed entirely according to the rules, without mistakes, and the phrase from line 4 is truly poetic.

<sup>3</sup> Since the Didactic cinquain method is introduced for the first time in the training of the students of the major

"Bulgarian Language and History", a special questionnaire was developed to find out what is the attitude of the students.

**Winter***White, frosty**It snows, it covers, it piles up**I drink tea in the warm hut.**Beautiful!***Perspectives**

The work with the Didactic cinquain method shows that it is very suitable for use in the discipline "Children and Teenage Literature". In the academic year 2021/2022 it was also successfully used in the teaching of other subjects – "New Bulgarian Literature" (3<sup>rd</sup> year, specialisation "Bulgarian Language and History") and "Legal Language and Style" (1<sup>st</sup> year, specialisation "Law"). Its use is to be extended to other courses in order to make the results representative.

**Conclusion**

Analysing the achieved results, we believe that the set didactic and educational tasks have been largely realized. The realized feedback from the learners, obtained through the completed questionnaire<sup>4</sup>, reveals that they liked the creative task. Although few students had written cinquains on concepts specific to the discipline, 25 people said that writing a cinquain helped them in making sense of some of the terms or characteristic themes, and 8 people answered *somewhat*.

Interesting are the answers to the question *What is the usefulness of writing a cinquain for students' learning?* Here we will present the most numerous answers: 10 people think that it develops thinking activity; 8 people – helps to realize creativity, imagination, and creative potential; 2 answers each: additional knowledge; developing poetic skills; developing speech skills and expressive abilities, enriching vocabulary, etc.

It is pleasant that some prospective teachers recognize didactic cinquain as an interesting, useful, and effective method of teaching. Learners felt that it could be successfully applied in secondary school but also saw potential in working with preschool children who would develop their speech. Three respondents said

they recommend the method and would use it with their current and future students.

The application of didactic cinquain in higher education revealed its great educational potential in teaching and showed that it was very well accepted and positively evaluated by students as it was easy to implement, entertaining but also effective.

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<sup>4</sup> The study involved 39 participants out of 49 students enrolled in the Literature for *Children and Teenage Literature* course.

# POLITICAL SCIENCES

## THE IMPACT OF GLOBALIZATION ON DIPLOMACY: HISTORICAL TRADITIONS AND MODERN APPROACHES

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### ABSTRACT

The article examines and analyzes the impact of globalization on diplomacy: to impact diplomats, diplomatic methods and diplomatic institutions, and the resulting issues. In general, changes in the role and essence of diplomacy at a time of deepening globalization, the application of new approaches in diplomacy, the points that necessitate a new structural change have been highlighted in scientific work. Given that globalization is a process, it can be concluded that its study is still relevant. Although its research has been conducted in many forms, it seems that there is still a need for in-depth and comprehensive research on diplomacy.

**Keywords:** globalization, diplomacy, diplomatic methods, diplomatic institutions.

### 1. Introduction

The use of the tool of diplomacy in international relations, which helps to implement the foreign policy of states, is as old as human history, but has been of interest for centuries. Until the time we live, diplomatic activity and the institution of diplomacy are becoming increasingly important. In our rapidly globalizing world, with the rapid intensification of international relations, it is safe to say that diplomatic activity will continue to grow.

As a result of "new problems" and "new actors" in the field of diplomacy, traditional diplomacy has necessitated structural changes in organizations. As a result of rapid changes in the field of communications and transport, heads of state and government, ministers gradually began to assume diplomatic posts. As a result of these developments, it is claimed that the traditional "diplomat" type should be replaced by expert bureaucrats, technicians and politicians [8, p.12].

New and rapidly spreading technology has also changed the political and social context of the old world of diplomacy. The diplomacy of the 21st century, which we can call global diplomacy, is not only a method of diplomacy between states or governments, but also a kind of "civil society diplomacy", unlike the old method[1]. In other words, "new diplomacy" has become a method of diplomacy in which the weight of the public is felt through community-oriented practices.

The solution of "new problems" in the new sphere of communication with global diplomacy and the existence of new actors make it necessary to carry out structural changes in traditional diplomatic organizations. Given the current situation, the diplomacy carried out by the state's foreign relations agencies for peaceful purposes has gone through many stages before reaching this stage.

### 2. The impact of globalization on diplomats

A diplomat appointed as "a person engaged in foreign policy and appointed to represent his country" was seen as the first method of diplomacy in the history of diplomacy. During this period, diplomatic representatives were temporarily sent abroad to

perform certain duties, and after performing these duties, they were recalled to their home countries.

Important innovations in the history of diplomacy were observed for the first time with the recognition of the right to diplomatic immunity by the Greeks and the emergence of the "proxenos", the first examples of today's consular post. In the ancient Greek city-states, diplomats did not go beyond being ambassadors. Their main task was to carry the message between the city-states. Therefore, the most important feature sought after by these first diplomats was that they had a strong voice and a strong memory that would allow them to remember the message they were conveying [8, p. 16].

Another feature of Greek diplomacy was its openness and democracy. The policy regarding the ambassador's missions was widely discussed in public, and the arguments that the ambassador would use on the other side were clearly defined. The instructions given to the apostles were extremely limited. Although the Greeks were limited, they created a diplomatic archive and a diplomatic language. The Greeks had three types of representatives, called presbys, keyrx, and prexenos. The first two, which could be translated as "messenger" and "old man," respectively, were assigned for short and multi-purpose missions.

Byzantine emperors, for the first time in history, created a public union whose specialty was foreign relations. This section provided training for ambassadors to foreign countries as professional speakers. During this training, ambassadors were taught the protocol and interview method they should pay attention to while performing their duties. In addition, the written instructions given to the ambassadors prior to their appointment reiterated the general and specific issues to be considered.

It was an old tradition to send emissaries to maintain relations between monarchs and rulers. With the steady transition of northern Italian city-states to diplomacy, the experience of the embassy became even more important. Renaissance Italy was important for the development of the diplomatic profession, which has always been active in foreign policy. Although

embassies of professional diplomats were established for the sole purpose of prestige, today they carry out many of the functions of embassies. As diplomats became an important source of information for both allies and enemies, great importance was attached to the diplomats' reports in terms of building the right foreign policy [2, p. 336].

In the 15th and 16th centuries, ambassadors were appointed to foreign countries for two years. They could not take their wives with them on the grounds of gossip, but they had to take their wives with them because of the possibility of poisoning by foreign chefs [13, p. 28]. The main qualities sought in these first permanent diplomats were: *they knew many languages, especially Latin, they were patient, tolerant, calm and hospitable, they were able to control their emotions and were not subject to scandals in their personal lives* [8, p. 19]. In addition, during this period, acts of diplomacy, such as meddling in the internal affairs of the host countries, engaging in destructive activities, espionage, and lying, were considered normal or even legitimate [6, p. 342-343].

Although the Italians formed the concept of diplomacy in the 15th and 16th centuries, the weight of the French in diplomacy was felt in the 18th and 19th centuries. The diplomatic profession began to take shape from professionals. In this century, diplomacy has become a profession, and diplomatic personnel have become a privileged class apart from society. In particular, diplomacy has become a professional group with personal and professional immunity, tax-free, free of customs, a luxurious lifestyle, and respected by the authorities.

Although Harold Nicholson emphasized the importance of changing the qualities of an ideal diplomat over time and space, he argued that some qualities of a diplomat should not change over time and space. The qualities that an ideal diplomat should have: *accuracy, confidence, calmness, good character, patience, humility and loyalty*. According to a more functional understanding of these qualities, Leache and Said say, *"A diplomat must understand the environment and the field in which he works, be well-defined, be flexible, and be willing to compromise with small concessions."* [6].

In the absence of communications, telegraphs and telephones, as well as vehicles, diplomats were endowed with some decision-making power. In a world where the media is not yet widespread, states have used intelligence from diplomatic missions in those countries as the only source to find out what other countries are up to.

Thus, as the nature of the international system and international relations has changed over time, there have been significant changes in the qualifications required for diplomats. In the Middle Ages and the beginning of the new century, when diplomats were considered personal representatives of rulers, qualities such as the physical structure of diplomats, the beauty of their spouses, and the fact that they were rich and noble were important [3, p. 134]. In the age of communication with globalization, dizzying events have led to many transformations and changes in terms

of the responsibilities of diplomats. For example, at a time when international communications and transportation were accelerated by telegraph, radio, and aviation, the foreign ministries were able to tighten control over foreign diplomats. With the invention of modern means of communication, the independence of diplomatic representatives working in foreign countries and the establishment of foreign policy were more strictly controlled than before [8, p. 62].

Although diplomatic missions were an important decision-making mechanism in foreign policy in the pre-World War I period, the so-called old diploma made the current diplomat an *"official at the end of the line"*. Diplomats who had previously had limited and delayed contact with the headquarters had considerable freedom in the line of duty, where they could only obtain information on the general framework of the subject and make their comments within that general framework. However, the unrestricted development of communication technology began to be replaced by both a common framework and video telephone calls, which severely limited the diplomatic freedoms of diplomats.

Technological developments in the era of globalization, on the one hand, stimulated the diplomatic missions to work more efficiently than in previous periods, on the other hand, created new options for the classical methods of providing information and made them relatively important. In fact, while in what we call "old diplomacy," diplomats attach great importance to intelligence, in a country with a technological revolution brought about by globalization, diplomats learn this information instantly online. In addition, researching local newspapers on a daily basis is one of the main responsibilities of current ambassadors. Diplomats evaluate and comment on newspaper reports in the context of the political, social and economic environment in their countries [8, p. 69].

According to another view, globalization is accompanied by a revolution in technology and communication, which makes society more transparent. In this case, it is emphasized that diplomats should gradually improve their communication skills [14].

Another innovation brought by globalization is personal diplomacy. As it is known, the reception of a country's ambassador is a very important event in the old diplomacy, but in the new diplomacy it seems that such ceremonies are no longer needed. Heads of state and government establish direct contacts with their counterparts through visits, means of communication and telephone conversations, contribute to the promotion of countries, the development of bilateral official and other relations [7, p. 57].

At the end of the visit, he is a diplomat who made vague promises and agreements a reality. The following words of the Canadian ambassador perfectly express today's diplomacy: *"You have been working silently and patiently on something for months, and when everything is ready, a minister comes and signs a paper with a golden pen. After that, everyone in the country says how educated he is and that we diplomats don't need him anymore."* [7, p. 69].

On the other hand, especially since the beginning of the twentieth century, it has begun to develop rapidly in the field of transport, giving different qualities to the concepts of time and space in international politics. Significant shortening of distances between the capitals of countries has allowed not only diplomats, but also foreign ministers or heads of state, who are the direct decision-making bodies of the countries, to participate in meetings to address important issues.

In addition, such events have significantly increased the public's interest and knowledge of foreign policy and, in a sense, revealed the phenomenon of "foreign policy integration." It is a fact that this situation limits the mobility of diplomacy and narrows the possibilities of resolving the problem through diplomacy. Diplomats comment on the information they receive in the country where they live, adding their views to the country's governments and parliaments [15].

In their mission to promote international trade, diplomats both respond to requests from various companies and explore new trade opportunities. This type of task is very new and unusual for traditional diplomats. Diplomats help and guide business people in the field of commerce and educate them about the commercial environment in their country. In addition, the organization of industrial fairs has become one of the important functions of diplomats [7, p. 71].

According to other diplomats, "the ambassador is an honest man sent abroad to lie in favor of his country." Although it is quite normal for diplomats to lie in the old diplomacy, this idea has lost its effect today. In diplomacy, the "moral" debate comes to the fore. According to former US Secretary of State Dean Acheson, "The important goal of diplomacy is to contribute to the good development of sustainable relations between states, and these relations should be conducted in a way that builds mutual trust." To achieve this, diplomacy must follow the same moral and ethical principles that build trust between people. "Today, the main rule is that diplomats refrain from making statements that do not reflect the facts [9].

In recent years, major powers have been particularly prone to the decline of diplomatic missions around the world. The reason for this may be a sharp reduction in costs. Therefore, ambassadors make great efforts to protect and maintain their missions [10].

All these developments have led to a relative reduction in the main functions of diplomacy in the classical sense. On the one hand, diplomatic representatives have lost their unrivaled position in providing political information to the country, on the other hand, the direct participation of diplomats in decision-making processes related to the country's foreign policy has decreased compared to the past.

### 3. The impact of globalization on diplomatic methods

Perhaps the most important change in the impact of globalization on diplomacy is seen in diplomatic methods. In the twentieth century, the great totalitarian states have developed some new methods of diplomacy. Perhaps the most important feature of the method of diplomacy used until the early twentieth

century is the secrecy of diplomacy. This confidentiality includes not only diplomatic negotiations, but also the results of negotiations. During this period, the country's leaders made even the most important foreign policy decisions in the direction of their personal interests and goals, without consulting the people, even without their knowledge.

At the end of the First World War, the world now faced a different international structure. With the development of technology, the qualities of the concepts of "diplomacy" and "war" have changed. The prevailing principles in interstate relations have changed their nature, and the practice of "secret diplomacy" has given way to the notion of "open diplomacy."

At the end of World War I, US President **Woodrow Wilson** introduced a new concept to diplomacy. The first of the "14 points" announced by President Wilson on January 8, 1918 was: "Open agreements to be reached as a result of open negotiations. After that, diplomacy had to be conducted in public. Open diplomacy has been linked to the realization of modern democracy". According to **Harold Nicholson**, a well-known writer of diplomacy, "new" diplomacy was nothing more than the application of the ideas that are the basis of liberal democracy in domestic politics, as well as in foreign relations [13, p. 73]. The first diplomatic method used in history was "ad hoc". Ad hoc was a one-sided and temporary method of diplomacy. In other words, diplomatic representatives were temporarily sent abroad to perform a specific task, and after completing this task, they returned to their home countries. One of the first examples of the practice of diplomacy is the diplomacy of the ancient Greek city-state [11, p. 22].

Along with the diplomacy of antiquity, with the fifteenth century there was a transition to "sustainable diplomacy", which meant the existence of permanent diplomatic committees before the Italian city-states. The protection of northern Italy by the Alps in the region, the difficulty of other countries' environmental degradation due to limited transport, communications, the Hundred Years' War in Europe and Europe's inability to fight Italy and Europe, the balance of power between these city-states was one of the reasons for its appearance [5, p. 79].

In the 16th century, there was an advanced diplomatic system among the great powers of Europe, formed by the adoption of permanent diplomacy. Diplomacy in these countries has made great strides at the institutional level.

According to experts, after the Vienna Convention, a new diplomatic method began to be used. Today, the relations between the states are more complex, tense and diverse than in the past, which necessitated the multilateralism of bilateral diplomacy. While diplomacy continued between bilateral rules until the seventeenth century, it became a multilateral communication within international organizations, especially in the diplomatic and technical spheres, which developed in the 19th century.

Although multilateral diplomacy, also known as parliamentary diplomacy or conference diplomacy, has

its origins in the Congress of Westphalia, it has developed significantly since the First World War due to the increase in the number of countries, mainly within the United Nations system. The gradual spread of continental and regional cooperation structures has increased the importance of multilateral diplomacy. However, today a new type of diplomacy is being developed in the economic and social aspects of cross-border relations between countries through "*Non-Governmental Organizations*". Among the most famous, such organizations as Grenpeace, the International Committee of the Red Cross, Amnesty International carry out many activities such as economic development, benefiting international public opinion.

Another new form of governance can be called "good governance" diplomacy. This type of diplomacy is defined as the intervention or assistance of the international community, especially governments, to countries that are unable to pursue policies that are adequate to their societies or that cannot be governed by internal turmoil. Habitat, Rio Summit, etc. conferences, global environmental conferences, security operations of the United Nations and other international powers, the establishment of special commissions within the UN are examples of good governance diplomacy [4, p. 352].

#### 4. The impact of globalization on diplomatic institutions

The end of the Cold War necessitated the collapse of communism, the division of some states into new states, and the emergence of new states that were not under the control of the superpowers. The Institute of Diplomacy also had to keep up with these changes [7, p. 66].

In addition to the foreign ministries and diplomatic staff, many other agencies also play a role in international relations. For example, the Ministries of Labor, Justice, Home Affairs, Treasury, and Agriculture may establish direct contacts with other government officials in their respective fields and establish contacts with international organizations. In the context of the development of these relations, it should be noted that the relations carried out through the foreign ministries and embassies in Western countries have replaced them.

As globalization seems to be a natural phenomenon, the state system is gradually becoming part of global politics. In this system, diplomats are expected to participate in some form of different policies, negotiations will expand, and mediation will be the key to diplomatic methods. Diplomats are expected to play a mediating role between the state and politics in this system [12].

Although traditional embassies in the capitals, which are the traditional form of diplomatic missions, still retain their importance, their functions have changed. The number of special missions sent by foreign ministries in mediation missions has increased. The development of summit diplomacy through meetings in international organizations is more crucial in diplomacy. In fact, multilateral relations have been

the main framework of diplomacy, without which it is almost impossible to maintain bilateral relations.

#### 5. Conclusion

The study leads to the conclusion that the change in communication and contact brought by globalization has led to the emergence of a method of public diplomacy, and classical diplomacy has been replaced by new changes and perspectives.

This study compares and connects the experiences and processes of individuals, communities and states in the history of mankind in a globalized world, and assesses the contributions and differences of diplomacy in the history of mankind. Although all diplomatic processes differ from each other, it has been shown that they are complementary disciplines. Naturally, the historical process influenced the formation of the digital diplomacy system. The study assessed the sub-dimensions, differences and similarities of diplomacy. After reviewing the results of the study, recommendations for future research and researchers were made within the scope of the study.

It is important for diplomacy to develop, plan, implement and monitor effective strategies to achieve the organization's goals. The organization of digital governance is a very important task of top management, as it is concerned and guides the future of societies. Now international relations revolve around digitalization. While digitalization, which is an important factor on the world agenda, cannot eliminate all old diplomacy and its traditions, it is leading to radical changes in diplomacy.

In today's diplomacy, the main task of a diplomat is to be impartial and honest, to refrain from statements that do not reflect the facts.

In the past, diplomats were very good orators and nobles, but in today's diplomacy, it is a common requirement for a diplomat to have a very good education and professional experience, to study law and economics.

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# SOCIAL SCIENCES

## STUDENT REVIEW: THE “MUQADDIMAH” OF IBN KHALDUN

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### ABSTRACT

In this review article, it will be first summarized the basic information about Ibn Khaldun, and his famous book called “Muqaddimah” and share our modest thoughts on this great work to understand the essence and value of the book. This study aims to emphasize that the work of Ibn Khaldun is an important scientific source for humanities and social sciences, especially sociology and related majors. In short, the purpose of this modest article is to explain “Muqaddimah” as it is an invaluable resource for young researchers.

**Keywords:** social sciences, humanities, history, review, global diaspora studies, epistemology, reading.

### 1. Introduction

In this modest student review article, we have first summarized the basic information about Ibn Khaldun's book, and we are sharing our thoughts about this short book aimed at understanding the essence and value of the book. Our goal is to emphasize that the book of the great scholar – Ibn Khaldun is an important source for science, especially sociology. In short, this small article aims to offer Muqaddimah an invaluable resource for social science researchers and to invite students of social sciences to study this book. So, in the following text, we will first talk about the life of the author of the book – a great scholar. Then, it turns to comments about the book. This article ends with a conclusion.

As our article is not a research study but is a “thought essay”, it is not containing any kind of empirical analysis or such kind of applied supplementary case study.

### 2. A brief word about Ibn Khaldun's life and work.

Abd-al-Rahman, Abu Zayd ibn Khaldun was born in the XIV Century, 1332 in the Christian dating, in Tunis. In fact, it has been written a lot about this great scholar's life and his works. There are also many separate paperbacks or essays on his autobiography and his famous work called the “Muqaddimah”. But traditionally, please allow us to talk a little about the scholar before we start discussing the core of the study.

So, Abd-al-Rahman ibn Khaldun was one of the most remarkable people in history. He, perhaps the first philosopher of history, sees speculative (or *hypothetical*) philosophy as not very useful, except as a method of inquiry. But it was Ibn Khaldun who identified the ossification (i.e., conformity) of tradition and intellectual stagnation (i.e., immobility) that muted the Islamic World. In his time, philosophy was in rapid decline, at least in the Sunni World – a major part of Islam. In other words, Ibn Khaldun always has a place amongst giant people in history – he was one of the greatest social analysts of the medieval Islamic world.

Abd-al-Rahman Ibn Khaldun (*in the following text, we write as “Ibn Khaldun”*) – came from a family of lawyers and government officials, Ibn Khaldun survived a turbulent period of Maghreb dynasty clashes (i.e., conflicts) and political unrest (turbulence). And

his father actually became very devoted, he had been a politician, but he got out of it. And he did not want his son to go into it. That is his father actually raised his son not telling him about the whole family of Andalusia. Because they were a Yamani family, they had a very noble lineage, and they were all Ministers. Ibn Khaldun discovered his lineage from reading “*Jamhrat Ansab*” (*Al-Andalusi, 2001*) because at that time he was reading the book of genealogy – that means, he found his genealogy – they were all ministers and he immediately set out for Andalusia to do what kind of political affairs (*Hamza Yusuf, 2017*).

According to commentaries about him, his skills and abilities allowed him to enter the inner circle of the rulers of Morocco, Tunisia, Algeria, and Granada. His first-hand experience in courtroom politics enabled him to gain an important understanding of the dynamics of social power in various contexts. Because he definitely had political ambitions. It was initially a disappointment for his father. Thus, (some) commentators from the Western side have seen him as arrogant (*McLemee and Irwin, 2018*). But to be born that kind of genius at a relatively mediocre age; so, there were a lot of interesting challenges in his life.

So, at the age of 50, Ibn Khaldun took up a scholarly degree at the great Jami'ah (educational institution) namely “Al-Azhar” (current Al Azhar University in Cairo, Egypt), and later temporarily became Egypt's chief judge (Islamic jurisprudent, and judge: “*qodi*”). Also, Ibn Khaldun accompanied the successor of the Sultan on his journey northeast (it was Central Asia, current Uzbekistan), where he met the great Emperor of his time – Amir Timur (or Tamerlane). They even had a series of talks with each other. Their discussions touched on many topics, from the nature of group solidarity to the demands of urban civilization and beyond. Ibn Khaldun died at the age of 74 in Cairo (*Marko, 2019*).

### 3. Student's modest review about the “Muqaddimah”

#### 3.1. Meaning of the “Muqaddimah” and its essence

Before we get into the scope of Ibn Khaldun's book, let me mention a little bit about knowledge. Be-



cause the basis of this modest work is to learn something beneficial and thereby share knowledge. Franz Rosenthal, one of the great Orientalists of the 20<sup>th</sup> Century, wrote a book called “The Knowledge Triumphant” on the importance of knowledge. In lieu of information, Franz Rosenthal was a famous Jewish Orientalist and one of the translators of Ibn Khaldun’s “Muqaddimah” into English. So, one of Franz Rosenthal’s points is that a unique civilization is one whose sole purpose is to acquire, develop, and spread knowledge (Rosenthal, 2007). Therefore, the essence of our research, which combines the work of Ibn Khaldun and geography to study a specific topic, is to contribute to the acquisition of knowledge and to share it with others.

So, this great scholar – Ibn Khaldun put his knowledge to good use in the “*new historical science*” presented in his masterpiece “Muqaddimah”. This book is the first volume of his book called “Great World History”. The “Muqaddimah” is often translated as “Introduction” or “Prolegomenon”; the “Muqaddimah” is the most important work of the Islamic story of the pre-modern world. So, Ibn Khaldun took off the time to write his book “Muqaddimah”. This masterpiece’s name in logic is a technical term for the *major* and *minor premise* (like proposition) before you get – called “result”. “Muqaddimah” is an Arabic word that means “*to put something forward*”.

This masterpiece is actually seven volumes, but mostly we have an abridged form of the book. There are different editions of it but in Arabic, the abridged form is three volumes. Some scholars mentioned that the abridgment version is not bad, it was done in the 1950s, and for the information, some of its translations are just wrong, and some of them are actually mistranslations, according to pious analytics (Hamza Yusuf, 2017).

Thus, the “Muqaddimah” is Ibn Khaldun’s attempt to reveal history’s hidden or inner principles that lead to the *rise* and *fall* of dynasties. The most interesting thing about Ibn Khaldun is that he was completely aware that he was doing something that had never been done before (that’s quite extraordinary!).

This important work introduces his multi-volume world history and remains an enduring classic in the Islamic tradition. It presents the science for understanding human civilization and social organization by exploring the philosophy of history that later became known as sociology, economics, etc. Using a multidimensional approach to history, including geography, climate, social psychology, law, economics, and culture. Ibn Khaldun offers a variety of explanations for the trends and trajectories of civilization. This work is not only for trained Muslim jurists but for anyone interested in understanding the complexities of human society and civilization from the perspective of one of the most brilliant minds in human history. (*If you read this work closely, it would be definitely essential reading!*).

Thus, Ibn Khaldun is a great scholar, if you read his work (i.e., “The Muqaddimah”), you can see that he

basically wants to understand how society came into existence, and what causes its decline and fall. Maybe that is why Ibn Khaldun was called the father of sociology. As he was studying society, the book is about what is a society – how it comes into existence, what’s its nature and what’s causing its decline. So, he – Ibn Khaldun goes into each of those.

### 3.2. Related studies on the “Muqaddimah”.

Charles Issawi (1987) brilliantly summarized some of the most salient features of the Muqaddimah (“An Arab Philosophy of History”, 1987). Issawi has an excellent introduction and explanation of Ibn Khaldun’s methodology. According to some analytics, Issawi’s book is an excellent book to read after reading the *Muqaddimah* to highlight and help remember some of the most important and original insights of the work.

Ahmad Zaid (2010) presents a comprehensive analysis of the final chapter of the Muqaddimah dedicated to knowledge and education (“The Epistemology of Ibn Khaldun”, 2010). According to Zaid, Ibn Khaldun brilliantly saves this most important chapter for last, as he sees knowledge to be the culminating crown of any true civilization.

Syed Farid Alatas (2015) wrote about Ibn Khaldun and his work – “Muqaddimah”. He presents a brief biography of Ibn Khaldun and a survey of his major achievements in social science, followed by a final section on “Muqaddimah” dealing with Ibn Khaldun’s views on education and his scientific presentations.

Johnson Steve (2015) examines Ibn Khaldun from a contemporary perspective considering previous Muslim philosophers and the kalam tradition<sup>5</sup> (Ibn Khaldun’s Epistemology and Philosophy of Mind, 2015).

Irwin Roberts (2019) wrote about Ibn Khaldun and noted his “Muqaddimah” in his paperback namely “*Ibn Khaldun: An Intellectual Biography*”. According to Irwin Roberts, this book is an excellent biography written by Ibn Khaldun, focusing on the education, intellectual approach, and historical background in which he worked. A prominent Arabist, Irwin offers a nuanced view of his great mind. Roberts examines Ibn Khaldun’s Sufism and how it influenced his approach to history. He has also researched the fascinating legacy of “Muqaddimah” in the Muslim world and elsewhere since Ibn Khaldun’s death, helping both to explore the work itself and gain new insights into many of its subjects. Roberts also explores Ibn Khaldun’s fascinating life that Ibn Khaldun was both a genius and a staunch orthodox Muslim, well versed in the jurisprudence of the Holy Book of Islam (Quran) and Maliki (one of the recognized schools of thought of Islam).

### Conclusion

From this article of ours, you have learned that Ibn Khaldun’s work is very important to study. We would like to emphasize that if you are doing research in today’s socio-humanities through this work, this work will be of great help in determining the theoretical foundations of your direction. In other words, the knowledge contained in the “Muqaddimah” is a wealth of information on history, politics, and economics,

<sup>5</sup> **Note:** *Kalam* is a speculative theology in Islam. The term comes from the Arabic expression “*kalamulloh*” - “word of God”, which refers to the *Quran* (the Holy Book of Islam).

See at <https://en.wikipedia.org/wiki/Kalam>

which can become the basis of modern research in each field.

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# TECHNICAL SCIENCES

## ОЦІНКА УМОВ РОБОТИ ВИХРОСТРУМОВОГО ПРИСТРОЮ ДИНАМІЧНОГО РЕЖИМУ КОНТРОЛЮ

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## EVALUATION OF THE OPERATING CONDITIONS OF THE EDDY CURRENT DEVICE IN THE DYNAMIC CONTROL MODE

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### АНОТАЦІЯ

Розглядаються результати роботи динамічної системи вихрострумове контролю. Розроблено макет системи, що дозволяє проводити контроль металевих зразків у динамічному режимі. Розроблено математичну модель, яка описує зміни інформаційних критеріїв сигналу відгуку у залежності від матеріалу досліджуваних металевих об'єктів та швидкості лінійного переміщення їх відносно котушок системи контролю. У дослідженні акцентовано увагу на пошуку оптимальних швидкостей роботи системи контролю. Запропоновано інтегрально-диференціальний підхід для визначення максимуму інформації між сигналами-відгуками отриманими від різних металів. Визначено оптимальний діапазон швидкостей сканування, що дозволяє отримати максимальну чутливість інформаційних критеріїв для різних металів, та може бути використаним для побудови мобільних систем вихрострумове експрес контролю.

### ABSTRACT

The results of the dynamic eddy current control system are considered. A layout of the system was developed, which allows control of metal samples in dynamic mode. A mathematical model has been developed that describes changes in the information criteria of the response signal depending on the material of the investigated metal objects and the speed of their linear movement relative to the coils of the control system. The research focuses on finding optimal operating speeds of the control system. An integral-differential approach is proposed for determining the maximum information between feedback signals obtained from different metals. The optimal range of scanning speeds has been determined, which allows obtaining the maximum sensitivity of information criteria for various metals, and can be used to build mobile eddy current express control systems.

**Ключові слова:** електромагнітні властивості металів, вихрострумівий перетворювач, дистанційна ідентифікація металів, математичне моделювання, амплітудно-фазовий метод реєстрації сигналів.

**Keywords:** electromagnetic properties of metals, eddy current converter, remote identification of metals, mathematical modeling, amplitude-phase signal registration method.

#### • Постановка проблеми

The task of detection and identification of metal objects in various fields of science, technology, maintenance control and military affairs has always been relevant. This is related to the search for hidden explosive metal objects, communications, the determination of the metal from which an unknown object is made, the identification of found metal nuggets in mining. For

their search (detection), electronic devices (metal detectors) are used, built on the registration of differences in the electrical and magnetic characteristics of hidden objects and the environment in which they are located. Such devices, in addition to searching, carry out preliminary metal identification. They work in a dichotomous mode. That is, it is determined to which subgroup of the subgroup of metals the material of the investigated control object belongs. Known metal detectors

are built on the basis of the eddy current method for detecting metal objects and divide them into black and non-ferrous, but do not provide the ability to determine metal within subgroups, that is, they cannot distinguish gold from aluminum or copper, nickel from steel, etc.

The final identification of the composition of a metal object is carried out by laboratory analysis using various methods, in particular, X-ray, optical emission, eddy current [1]. It is quite effective to use the dynamic method proposed by the authors in [2], which is also based on the eddy current method of detecting metal objects [3]. Theoretical issues of the formation of signals of a dynamic eddy current system were considered in a number of works [3-5], but they do not fully explain the change in the shape of the response signal obtained as a result of probing the investigated metal object.

- Аналіз останніх досліджень і публікацій

The existing mathematical models that explain the operation of the eddy current method of detecting metal objects cannot fully explain the occurrence of the signal and do not reflect the informative features that characterize the differences of metals embedded in the form of the response signal. In particular, these are the models of K. Brushini [3], Hrynyova A.Yu. [4] and the model is taken from the theory of non-destructive testing [5].

- Виділення невирішених частин загальної проблеми

Eddy current devices, which distinguish materials from each other by magnetic permeability and electrical conductivity, are used to detect metallic objects. They can have different schematic implementations, structural and technical characteristics. However, such a parameter as scanning speed is not regulated for them, which largely depends on the shape of the response signal. And this is important for solving the problem of identification of metal objects.

- Мета статті

This publication proposes a mathematical model of the formation of the response signal of a dynamic eddy current system [2], which allows identifying the metal from which it is made based on the electromagnetic parameters of the object under study, and provides the results of optimizing the scanning speed of the system in question.

- Виклад основного матеріалу

We will show that the differences in metals depend on their electromagnetic characteristics. For this, we will use the model described in [5]. In this model, the voltage at the output of the receiving coil of the  $U_{BД}$  eddy current converter is determined by the electromagnetic properties of the investigated control object (OC) and the parameters of the coils:

$$U_{BД}(x, t) = j\omega \mu_0 \pi N_{Д} N_3 R_{Д} \text{Im} \cos(\omega t) \cdot (1)$$

$$\cdot \int_0^{\infty} \varphi_1(x, \beta) J_1(x R_{3*}) J_1(x) e^{-x h_*} dx (3.2)$$

where  $N_{Д}$ ,  $N_3$  – the number of turns in the receiving and transmitting coils of the frame type;  $J_1$  – Bessel function of the first kind of the first order;  $\lambda$  –

integral transformation parameter;  $R_{Д}$  – the radius of the receiving coil;  $R_3$  – the radius of the transmitting coil;

$$h_* = \frac{h_3 + h_{Д}}{R_3}; \quad R_{3*} = \frac{R_{Д}}{R_3}.$$

where  $h_3$  – the height of the transmitting coil,  $h_{Д}$  – the height of the receiving coil.

That is, the magnitude of the signal presented in the receiving coil depends on the parameters of the coils. In our case, the coil system had the following geometric dimensions:  $R_3 = 80$  mm,  $R_{Д} = 40$  mm,  $h_3 = 5$  mm,  $h_{Д} = 5$  mm,  $N_3 = 85$ ,  $N_{Д} = 280$ ,  $x = \lambda R_3$ .

In this model, such a characteristic as the influence function is introduced  $\varphi_1(x, \beta)$  [6,7]. It takes into account the electrical and magnetic properties of metals, and can be used to estimate the difference in feedback signals obtained for different metals:

$$\varphi_1(x, \beta) = \frac{\mu_r - \sqrt{x^2 + j\beta^2}}{\mu_r + \sqrt{x^2 + j\beta^2}}, (2)$$

where  $\mu_r$  – relative magnetic permeability,  $x = \lambda R_3$ ,  $\lambda$  – integration parameter [1/m],  $\beta = R_3 \sqrt{\omega \mu_a \sigma}$ ,  $\sigma$  – electrical conductivity of metal,  $\mu_a$  – absolute magnetic permeability.

For example, we will show the difference in function values for steel, nickel, lead and electrotechnical copper. As is known, the relative magnetic permeability of steel  $\mu_r = 100$ , copper  $\mu_r = 1$ , nickel  $\mu_r = 100 \dots 600$  (use 100), lead  $\mu_r = 1$ , conductivity of steel  $\sigma = 7,69 \cdot 10^6$  sm/m, copper  $\sigma = 58,1 \cdot 10^6$  sm/m, nickel  $\sigma = 11,5 \cdot 10^6$  sm/m, lead  $\sigma = 4,81 \cdot 10^6$  sm/m. The authors calculated the values of the influence function  $\varphi_1(x, \beta)$  for various metals:

$$\begin{aligned} |\varphi_{1steel}(x, \beta)| &= 0,802, & |\varphi_{1nickel}(x, \beta)| &= 0,833, \\ |\varphi_{1copper}(x, \beta)| &= 0,992, & |\varphi_{1lead}(x, \beta)| &= 0,972. \end{aligned}$$

Data analysis shows that the difference between the influence functions for copper and steel is more than 19.0%, and for copper and nickel - more than 16.0%. This makes it possible to identify the metal from which the OK is made by the value of the  $U_{BД}$  voltage and its change over time.

Information about the material of the metal OC is also carried by the phase shift between the probing signal and the signal transmitted in the receiving antenna. In works [8, 9] it is proposed to use the spectral characteristics of the response signal, and in [2,10] the method of graphic-digital images, which allows analyzing the signal in the time domain.

Consider the structural diagram of the modified dynamic system (Fig. 1). It consists of electronic units used in metal detectors (probing signal generator, output amplifier, low-noise input amplifier of the signal presented in the receiving coil, phase detector) [3] and

a digital signal processing unit based on a microcontroller. The system is supplemented with a rotary setup, which is used for dynamic measurement of the response signal with the possibility of changing the frequency of rotation of the OK on the coils and for studying the effect on the shape of the response signal of the speed of movement of the investigated object relative to the block of coils (dynamic measurement of the response signal).

The coil unit (transmitting and receiving coils) and analog electronic unit and advanced digital processing

unit based on a modern microcontroller, which provides identification of the material of the metal object using the graphic-digital image and spectral methods developed by the author [3], are unchanged. It is the presence of a rotary device (Fig. 1) that allows the dynamic measurement method to be implemented. The general appearance of the installation is shown in Fig. 2. The studied samples are moved with the help of a mechanical system made on the basis of an electric motor of the KD6-4 type (Fig. 3). The minimum sample is 10x10x1 mm and the maximum is 80x80x5 mm, for this size range the results of the study are correct.

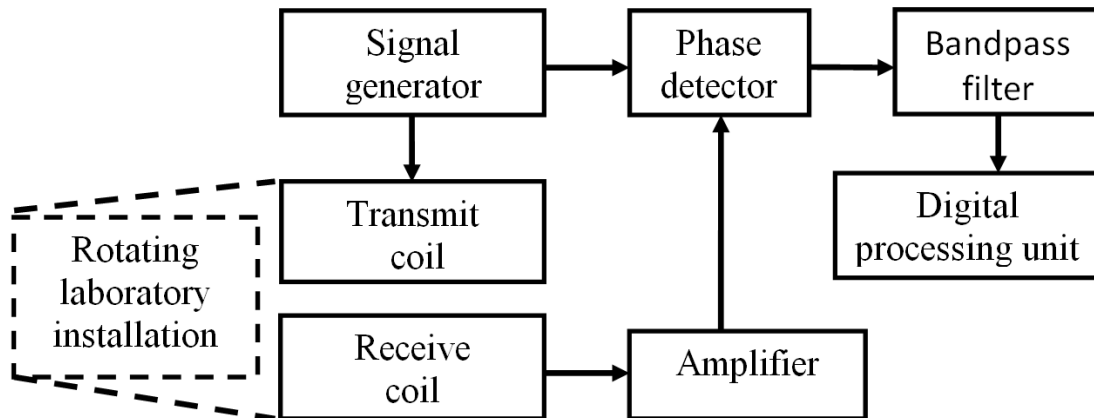


Figure 1 – Structural diagram of the developed eddy current system

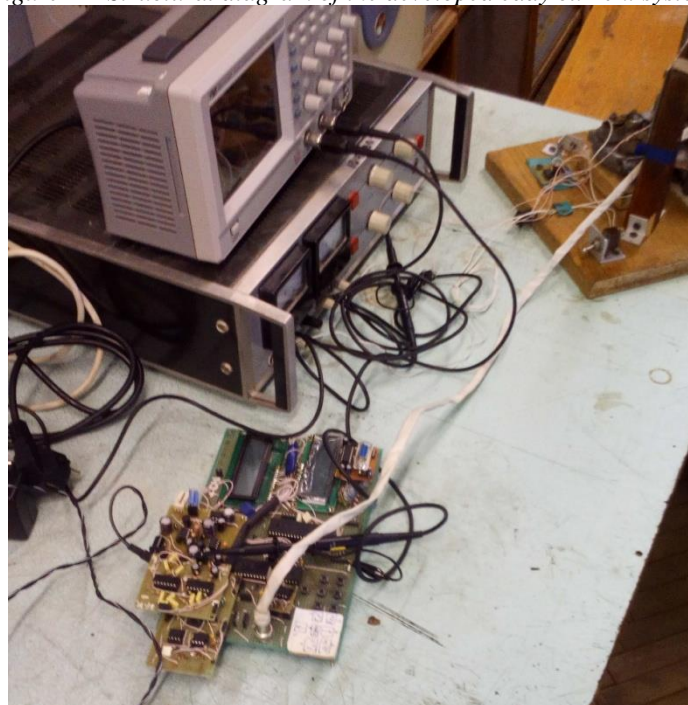


Figure 2 – Appearance of the laboratory identification system

The response signal resulting from the interaction of the signal emitted by the transmission coil with a metal object carries information that depends on its electrical and magnetic properties, and on the basis of which a response signal specific to a particular metal is formed. This signal is not an absolute characteristic of a particular metal, but depends on a number of technical parameters of the system, such as the speed and stabil-

ity of the relative movement of the OK and the coil system. Therefore, there is a need to take into account these parameters and stabilize the trajectory of the coil relative to the object. Rotating laboratory installation (Fig. 3), which allows changing the relative speed of movement of metal samples and the antenna in a plane parallel to the antenna in the range from 2 to 8 m/s.

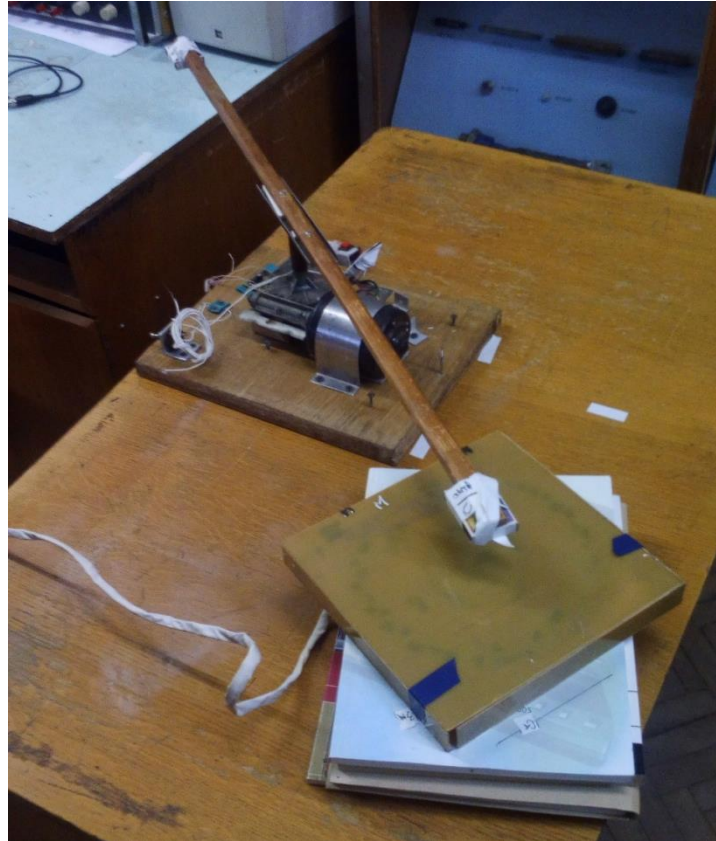


Figure 3 – Rotating installation: the process of controlling metal samples

The feedback signal at the input of the phase detector, which is the main element of the control system that forms the investigated signal, depends on the position of the OK relative to the coil block. Without its fixation, the signal-echo is a relative characteristic of the metal, which becomes absolute only after comparing the signals obtained from different metals, taken at the same relative speed of movement, and creating a database of signals, which is necessary for their mutual comparison. Write the feedback signal:

$$U_3 = U_{130} \cos\left(\frac{V}{L}t\right) \cos(\omega t + \varphi(t)), \quad (6)$$

where  $\varphi(t) = \varphi_{noy} + \frac{\Delta\varphi}{\varphi_{max}}t$ ,  $\varphi_{noy}$  – the initial value of the phase shift,  $\varphi_{max}$  – the maximum value of the initial phase shift,  $\Delta\varphi$  – initial phase change step,  $U_{130}$  – voltage in the receiving coil, taking into account the movement of the metal OK,  $U_{130}$  – the basic value of the voltage on the coil,  $V$  – linear speed of OK movement along the turns of the coil,  $L$  – the distance between the receiving and transmitting coils.

The signal  $U_3$  is fed to the input of the synchronous detector [11], at the output of which there is a signal corresponding to the phase shift between the reference

(probe) signal and the signal presented in the receiving antenna.

The signal at the output of the synchronous phase detector  $U_a$  corresponds to the nature of the change in phase and amplitude:

$$U_a = \begin{cases} 0 & f_3 \neq f_{onop} \\ \frac{1}{2} U_3 \cos\varphi & f_3 = f_{onop} \end{cases},$$

where  $U_a$  – voltage at the output of the synchronous phase detector,  $U_3$  – voltage at the input of the phase detector,  $f_3$  – frequency of the signal at the input of the phase detector,  $f_{onop}$  – frequency of the reference signal (the frequency emitted by the coils system),  $\varphi$  – phase shift between signals,  $U_{onop}$  – reference signal voltage.

Next, the  $U_a$  signal is converted into a digital code and processed in the electronic unit by digital methods proposed in [2], which allows identification of the metal from which the control object is made.

The purpose of processing is to extract information coefficients characterizing a specific metal or alloy. These are the number of extremes, their mutual relationship, the area of the spectrum under the contour, the curvature of the spectrum contour, the lower and upper limits of the spectra. They can be imagined as a row matrix  $f(K\%, E_{cum}, KOP, S_{xs}, f_n, f_v)$ .

Schematically, the identification process can be imagined as:

$$U(V, \sigma, \mu) \Rightarrow [\Phi] \Rightarrow f(K\%, E_{cum}, KOP, S_{xs}, f_n, f_v),$$

where  $\Phi$  – a nonlinear filter, after passing through which information coefficients are extracted.

At different speeds of movement of the OK relative to the coil, the shape of the signal will be different, accordingly, the informative coefficients will also be

different. Correlation of coefficients among themselves for different metals will lead to better or worse identification. Therefore, it is appropriate to determine the optimal speeds (rotation frequencies) of the rotary installation, which will ensure the maximum possible accuracy of identification of the OK material.

Previous results of row matrices did not contain information about the speed of movement of the OK relative to the coil system, because the filter extracts only information coefficients. Therefore, it was appropriate to investigate the effect on the response signal of the speed of movement of the OK relative to the antenna system.

The classic analysis of finding extremums [13,14], which involves calculating the derivative of one of the variables and equating the result to zero, is not acceptable, because the criterion for maximum information between metals is a row matrix, not an initial function.

In order to find the optimal speed of movement of metal samples above the coil, we suggest to alternately compare the derivative functions of the response signal by graphical and integral method.

The maximum graphic-integral difference of the derivatives for two different metals is a confirmation of the maximum correlation between the parameters of the metals being compared. Schematically, this method can be written as:

$$\int \frac{U_1(V, \sigma, \mu)}{\partial V} - \frac{U_2(V, \sigma, \mu)}{\partial V} \Rightarrow \max$$

$$\frac{U_1(V, \sigma, \mu)}{\partial V} = \frac{U_{130} \cos\left(\frac{V}{L}t\right) \cos(\omega t + \varphi(t))}{\partial V} =$$

$$-\frac{t}{L} U_{130} \sin\left(\frac{V}{L}t\right) \cos(\omega t + \varphi(t))$$

The values of the integral characteristics for 4 different metals are calculated in the work. They are presented in Fig. 6 (on the y-axis - area, graphically - integral difference). They show the cross-correlation characteristics for the range of rotation frequencies of the

moving part of the rotary installation from 10 to 18 Hz, which corresponds to the speed of linear movement of the OK relative to the antenna system of 2...8 m/s.

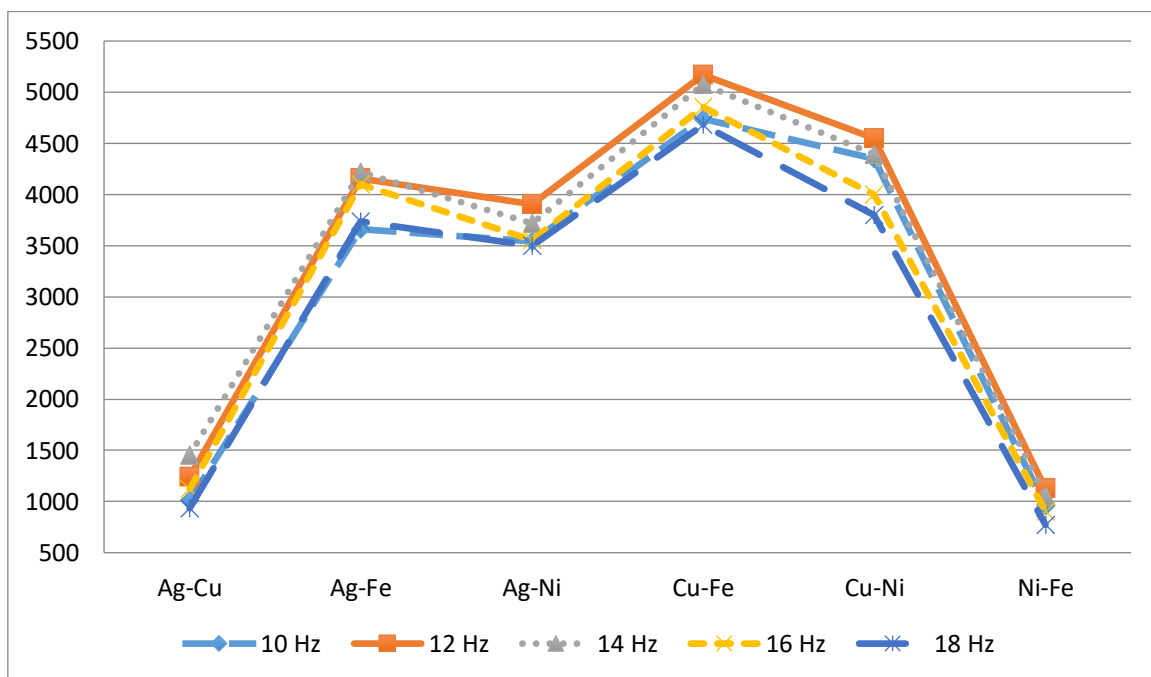


Figure 6. – Diagram of cross-correlation integral characteristics of 4 different metals

As the results of the experiments showed, at a significantly low rotation frequency, the informational effect is poorly manifested - the form of feedback signals is similar and does not carry information about the type of metals. And at too high a frequency, the responses turn into one extreme, which can be explained by insufficient charging of the OK by the secondary field.

The analysis of the diagram shows that there is no clearly defined optimal frequency, but there is a frequency range of 12...14 Hz, which provides the maximum correlation integral characteristic.

**CONCLUSIONS**

The proposed model for evaluating the results of the comparison of controlled metals is based on an integral-differential approach to determining the correlation difference of information criteria of spectral and

graphic-digital methods of identification of metal objects, allowed to experimentally determine the range of the optimal speed of movement of a metal object relative to the coil system, allowed to optimize the operation of the eddy current dynamic control method, which in turn significantly increased the accuracy of metal identification.

The obtained experimental results showed that the maximum of the correlation difference of the information parameters of the proposed eddy current dynamic system, for a rotary installation with a shoulder of 500 mm, lies in the range of 12...14 Hz, which corresponds to the range of linear velocities of 4...6 m/s.

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