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# CHARACTERISTICS OF SEX AND AGE COMPOSITION OF *CALIDRIS ALPINE* (AVES, CHARADRIIFORMES) MIGRATING ACROSS SIVASH

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**Characteristics of Sex and Age Composition of *Calidris alpine* (Aves, Charadriiformes) Migrating Across Sivash. Chernichko I. I.** — The paper shows features of distribution based on regular captures and measurements since 1986 on two sites of Sivash (Central and Eastern), which are different in their hydrological regime and composition of forage macrozoobenthos. Shorter-billed males reliably prefer Central Sivash for storage of fat reserves at the expense of feeding on larvae of chironomids and possibly the brine shrimp. For longer-billed females it is more profitable to concentrate on Eastern Sivash, where they prefer to feed on polychaete worms. On basis of size characteristics of the captured birds and their time dynamics, the paper considers suggested terms of passage of different subspecies and populations of the Dunlin across the Azov-Black Sea coast of Ukraine. Also differences in age composition of migratory waders on different sites of Sivash are shown compared to other water bodies of the near Black Sea area.

Key words: waders (Dunlin), migration, sex and age composition, the Azov-Black Sea coast of Ukraine.

**Особенности половозрастного состава мигрирующих на Сиваше *Calidris alpina* (Aves, Charadriiformes). Черничко И. И.** — На основании регулярных отловов и промеров чернозобика (*Calidris alpina* L.) с 1986 г. на двух участках Сиваша (Центральном и Восточном), различающихся своим гидрологическим режимом и составом кормового макрозообентоса, показаны особенности размещения самцов и самок во время сезонных миграций. Самцы, обладающие более коротким клювом, достоверно чаще избирают Центральный Сиваш для накопления жировых запасов за счет питания личинками хирономид и, возможно, артемией. Самкам, более «длинноклювым», выгоднее концентрироваться на Восточном Сиваше, где они предпочитают поедать полихет. На основании размерных характеристик отловленных птиц и их динамики во времени, рассматриваются вероятные сроки пролета на Азово-Черноморском побережье Украины разных подвидов и популяций чернозобика. Показаны различия и в возрастном составе мигрирующих куликов на разных участках Сиваша в сравнении с другими водоемами Причерноморья.

Ключевые слова: кулики (чернозобик) миграция, половозрастной состав, Азово-Черноморское побережье Украины.

## Introduction

The investigation of characteristic details of using stopovers by migratory waders is among the most actual and modern directions for studies of birds of this taxonomic group. Apart from migratory birds conservation problems and practical issues of developing a network of protected areas, such investigation is also connected with characteristics of spatial structure, the migration range for different population groups, territorial fidelity, duration of stopovers, moult of birds and storage of necessary fat reserves for further flight.

In Western Palearctic the most important stopovers of waders along the Eastern Atlantic flyway are well studied; among them are the Wadden Sea located along the North Sea coast, wetlands at the Atlantic coast of British Isles, continental Europe and Africa, for instance Banc d'Arguin in Mauritania (Boere, 1976; Engelmoer et al. , 1994; Have van der et al. , 1994; Meltofte et al., 1994). Stopovers of waders along inland water bodies in South Europe are poorly studied. Except for some wetlands, stopovers of waders along the Black Sea-Mediterranean coast and further inland were not investigated. Regular catches and intravital procession of waders

on stopovers give a comprehensive idea of migratory state of birds, body mass growth rate, moult, migration characteristics of different age groups. At the same time, assessment of sex composition and migration features of males and females for most of sandpipers are extremely poorly studied since it is impossible to identify the sex of the birds in field conditions according to their exterior. Only few researches are dedicated to the study of sex and age composition of some species of waders on stopovers in Western Europe (Spiekman et al., 1993; Have van der et al., 1994; Have van der et al, 1996; Dierschke, 1996). However, without identification of sex of migratory birds it is difficult to study a possible replacement of different population groups basing on their size parameters.

Studies of wader migration and regular captures along the Black Sea coast of Ukraine, started in late 1970s (Черничко, 1982), on the example of some species have proved a great importance of various wetlands of the region for moult, rest and replenishment of fat reserves. Catches and intravital procession of such a mass species as Dunlin (*Calidris alpine* L.) have shown essential differences in spatial and temporary distribution of different sex and population groups. The proposed paper considers distribution peculiarities of different sex and age groups of Dunlins in two neighbouring sites of Sivash.

**Material and methods**

Rather regular catches of waders at Sivash have been started since 1986. From that time and until 2004 4,632 Dunlins at Central Sivash and 15,620 at Eastern Sivash have been caught and measured. Seasonal variations in volumes of ringing more likely depended not on the total duration of the catching period but on the catching efficiency of nets in autumn, connected with duration of Dunlin stopovers on waterbodies of South Ukraine and increase of the area of feeding territories in that period of time.

As dates of catching did not always coincide from year to year, and volumes of samples were not identical, to receive a more reliable picture we used averaged results of catching for all years of researches for every decade of spring (April-May) and autumn (August-October) months. It allowed to level inter-annual variations and increase the reliability of results. Dissection of the Dunlins which casually died for all years of studies (n = 211) has shown some prevalence of males over females in the whole migratory passage (53.1% and 46.9% respectively).

In order to analyze sex and age structure of migratory groups of Dunlins in two sites of Sivash they were compared to results of catching on Tiligulsky Liman (3,547 individuals) over the period from 1986 to 2003. The number of measured individuals is presented in table 1.

Majority of waders either does not demonstrate any sexual dimorphism in coloration and sizes or it is overlapped by geographical variation (Prater et al., 1977; Cramp, Simmons, 1983). It is the reason which considerably complicates identification of sex at the individual bird level for most *Calidritinae* species of sandpipers. Bill length of Dunlins under influence of selective factors has gained traits of sexual dimorphism, and females generally have longer bills than males. It promoted decrease of food competition not only on breeding grounds, but also within a migratory range at the expense of widened spectrum of feeding habitats used by Dunlins (Юдин, 1961).

**Table 1. Supposed sex composition of Dunlins estimated based on wing and bill measurements for waders captured at Sivash during all the period of studies**

**Таблица 1. Количество отловленных птиц на Сиваше за весь период исследований и предполагаемый половой состав чернозобиков, рассчитанный на основании промеров крыла и клюва**

| Place | Season | Age | Males | Females | Sex? | Total | % sex? | % males* | % females* |
|---|---|---|---|---|---|---|---|---|---|
| Central | Spring | Adults | 451 | 311 | 280 | 1042 | 26.8 | 59.2 | 40.8 |
| Sivash | Spring | Underyearlings | 89 | 69 | 77 | 235 | 32.7 | 56.3 | 43.7 |
| | Autumn | Adults | 1098 | 610 | 754 | 2462 | 30.6 | 64.3 | 35.7 |
| | Autumn | Yearlings | 33 | 12 | 23 | 68 | 33.8 | 73.3 | 26.7 |
| | Autumn | Juveniles | 163 | 118 | 224 | 505 | 44.4 | 58.0 | 42.0 |
| | Total | **1834** | **1120** | **1358** | **4312** | **31.5** | **61.9** | **38.1** | |
| Eastern | Spring | Adults | 1809 | 1423 | 1117 | 4349 | 25.7 | 56.0 | 44.0 |
| Sivash | Spring | Underyearlings | 50 | 58 | 61 | 169 | 36.1 | 46.3 | 53.7 |
| | Autumn | Adults | 3431 | 2285 | 2536 | 8252 | 30.7 | 60.0 | 40.0 |
| | Autumn | Yearlings | 96 | 73 | 61 | 230 | 26.5 | 56.8 | 43.2 |
| | Autumn | Juveniles | 683 | 525 | 397 | 1605 | 24.7 | 56.5 | 43.5 |
| | Total | **6069** | **4364** | **4172** | **14605** | **28.6** | **58.2** | **41.8** | |
| **Total** | **7903** | **5484** | **5530** | **18917** | **29.2** | **59.0** | **41.0** | | |

Note. * — The percentage of males and females was calculated out of a total of birds which sex was identified (taken as 100 %). Adults — birds after the second calendar year; underyearlings — birds of the first calendar year in spring; yearlings — birds of the first calendar year in autumn; juveniles — birds born in a year of their catching.

Apart from sexual differentiation there are also population and subspecies distinctions in size which are also impossible to reveal at the individual bird level, but if analyzing the whole sample they influence on an empirical result of sex identification. On the other hand, comparison of different Dunlin population groups in concordance with their biometrical indices, without taking sex into account, is also incomplete. To find a compromise when analyzing size characteristics we have divided samples of captured Dunlins into males, females and a group of birds with the sex unidentified. The main criterion for sex identification was bill length. Attempts to use bill length for identification of the sex of sandpipers are known according to some literary sources (Spiekman et al., 1993), and other authors (Хоменко, Дядичева, 1999) who used a relative ratio index between wing length and bill length for Curlew Sandpiper (*Calidris ferruginea*). Similar studies for the Dunlin on Black Sea wetlands are not available.

On basis of statistical analysis (95% confidence interval) of wing and bill size of the Dunlins died during catching we have evaluated both criteria. Ratio index 'wing/bill' for females equaled to $\leq 3.42 + 0.01$ (n = 99), and for males $\leq 3.67 \pm 0.02$ (n = 122). As for percentage, they gave the same error as calculations based only on bill length. Due to this, main approach for distinguishing birds in a total sample according to their suggested sex lied first of all in analysis of bill length as it is the main part of the body expressing sexual dimorphism. Wing length of males is 96-98% of that of females, and bill length is 83–85%, respectively. Another reason for predominate usage of bill measurements is that the wing length of an individual bird fluctuates (within 3–5 mm) at the expense of seasonal wear-out of primaries and the value of this length also depends on moult conditions during annual change of plumage. At last, during the moult of distal flight feathers it is impossible to measure the wing length; for this reason, data on wing length are often not available in autumn. In connection with all these facts, we selected bill length of the captured birds as the main criterion. Birds with bill length $\leq 31.5 \pm 0.14$ mm (n = 122) we identified as males, and birds with bill length $\geq 35.0 \pm 0.17$ mm (n = 99) as females. Usually, 65–70% birds in the samples were distinguished in accordance with these size characteristics. Apart from this, among birds remained in the sample which bill lengths overlapped (small females and big males), we additively divided 8-10% of birds into sex groups basing on the ratio index of wing/bill length. In this case the error could not exceed 5–7%. This approach excluded identification of sex at the individual bird level, but gave a possibility to estimate general trends in changes of sex composition of migrants.

Measurements of wing length were done with a metal ruler (accuracy of 1 mm), bill length with calipers (accuracy of 0. 1 mm) according to a standard method (Spiekman, 1993).

## Results

Distribution of males and females. The data of dissection revealed insignificant prevalence (about 3%) of males over females. However, analysis of a real picture in the samples of captured birds gave other results. Average long-term data demonstrated that the neighboring sites of Sivash (Central and Eastern) were more different from each other in respect to the relative percentage of males and females (table 2), than territories 300–400 km apart.

Dunlin males predominate in early spring since they are the first to start migration. Figure 1 shows that before the first decade of May the proportion of males at Central Sivash (according to average long-term data) was still much higher than at Eastern Sivash, and these differences are reliable (Chi-Square = 25.32; df = 5; $p < 0.000$). Right after arrival, in the first decade of April, the percentage of males is almost equal on both analyzed sites of Sivash, but later an evident territorial differentiation of a migration group according to sex occurs.

Differences in sex ratio are the most pronounced in April (fig. 2). It is the beginning of the migratory period when males prevail everywhere, and in May the percentage of both sexes on two sites of Sivash equalizes.

**Table 2. Percentage of males and females (%) among Dunlins, captured in spring on two sites of Sivash (n = 3994)**
**Таблица 2. Соотношение самцов и самок (%) среди чернозобиков, отловленных весной на двух участках Сиваша (n = 3994)**

| Month, decade | Central Sivash | | Eastern Sivash | |
|---|---|---|---|---|
| | Males | Females | Males | Females |
| IV, 1 | 77.7 | 22.3 | 72.7 | 27.3 |
| IV, 2 | 90.5 | 9.5 | 67.4 | 32.6 |
| IV, 3 | 68.1 | 31.9 | 51.7 | 48.3 |
| V, 1 | 73.1 | 26.9 | 57.3 | 42.7 |
| V, 2 | 54.4 | 45.6 | 58.2 | 41.8 |
| V, 3 | 29.2 | 70.8 | 47.9 | 52.1 |
| **Total** | **65.5** | **34.5** | **59.2** | **40.8** |

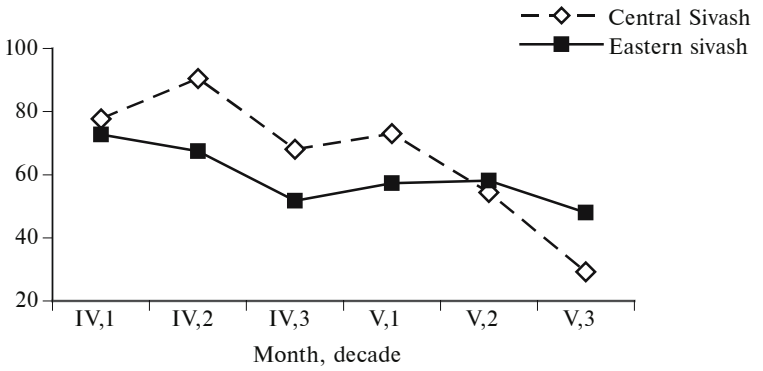


Fig. 1. Changes in the proportion of males among Dunlins captured in spring on two sites of Sivash.
Рис. 1. Изменение доли самцов среди отловленных весной чернозобиков на двух участках Сиваша.

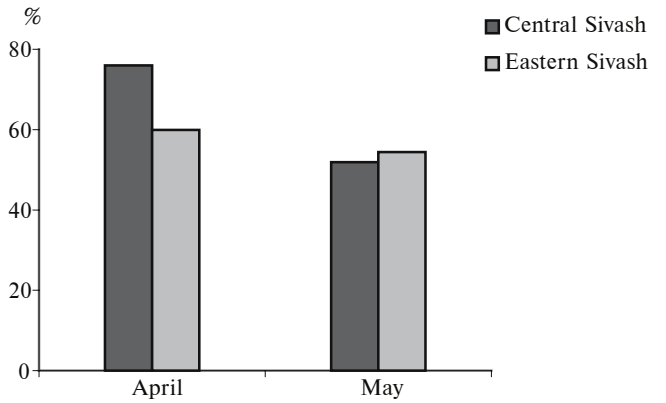


Fig. 2. Changes in the proportion of males on two sites of Sivash according to average data for two spring months.
Рис. 2. Изменение доли самцов на двух участках Сиваша по средним данным за два весенних месяца.

According to recaptures, bird stopovers in spring last for at least 12–15 days which are necessary to complete prenuptial moult and store fat reserves. Thus, a sustainable asymmetry in distribution of males and females are more likely explained not by differences in migratory routes of males and females but by a spatial differentiation, the reasons of which are considered below.

In spring, having completed the moult and reached necessary migratory state, Dunlin males are the first to leave feeding areas of the Azov-Black Sea coast of Ukraine. This process is more evident at Central Sivash because of the prevalence of males, and by late May the percentage of males in this site may be even lower than at Eastern Sivash (fig. 1, 2 and table 2).

When two sites of Sivash were compared with Tiligulsky Liman (north-western area of the Black Sea) it was found out that 'male/female' ratio at Eastern Sivash was much more similar to that at Tiligulsky Liman (table 3), and small observable differences are not statistically reliable (Chi-Square = 6.67; df = 5; $p < 246$). At the same time, differences between the male percentage at Central Sivash and Tiligulsky Liman are noticeable and reliable (Chi-Square = 26.65; df = 5; $p < 0.000$).

The males still predominate at Central Sivash during the autumn reverse migration (table 4) with differences not so sharp as in spring (fig. 3) but reliable (Chi-Square = 21.93; df = 8; $p < 0.005$). Decade differences in females ratio on two sites of Sivash turned out to be more significant than those of males, which is proved by the value of 'chi-square' (Chi-Square = 28.60; df = 8; $p < 0.0000$). A graph of dynamics of the

**Table 3. Ratio of males and females (%) among Dunlins, captured in spring on Tiligulsky Liman (north-western area of the Black Sea) (n = 1284)**

**Таблица 3. Соотношение самцов и самок (%) среди чернозобиков, отловленных весной на Тилигульском лимане (Северо-Западное Причерноморье) (n = 1284)**

| Month, decade | Males | Females |
|---|---|---|
| IV, 1 | 64.7 | 35.3 |
| IV, 2 | 60.4 | 39.6 |
| IV, 3 | 61.1 | 38.9 |
| V, 1 | 60.1 | 39.9 |
| V, 2 | 47.0 | 53.0 |
| V, 3 | 42.7 | 57.3 |
| **Total** | **56.0** | **44.0** |

**Table 4. Ratio of males and females (%) among the adult Dunlins, captured in autumn on two sites of Sivash (n = 7424)**

**Таблица 4. Соотношение самцов и самок (%) среди взрослых чернозобиков, отловленных осенью на двух участках Сиваша (n = 7424)**

| Month, decade | Central Sivash | | Eastern Sivash | |
|---|---|---|---|---|
| | Males | Females | Males | Females |
| VIII, 1 | 60.0 | 40.0 | 61.7 | 38.3 |
| VIII, 2 | 64.8 | 35.2 | 55.7 | 44.3 |
| VIII, 3 | 75.6 | 24.4 | 56.6 | 43.4 |
| IX, 1 | 54.8 | 45.2 | 56.8 | 43.2 |
| IX, 2 | 60.6 | 39.4 | 58.1 | 41.9 |
| IX, 3 | 67.7 | 32.3 | 64.2 | 35.8 |
| X, 1 | 72.9 | 27.1 | 66.4 | 33.6 |
| X, 2 | 83.3 | 16.7 | 67.0 | 33.0 |
| X, 3 | 69.2 | 30.8 | 48.3 | 51.7 |
| **Total** | **67.6** | **32.4** | **59.4** | **40.6** |

autumn male percentage at Central Sivash has two peaks (fig. 3), coinciding with periods of the most active migrations and arrivals of males to the Azov-Black Sea coast in late August and late October. These peaks can be also linked with dislocations of various population groups, existence of which are well traced when analyzing wing size (in some cases, bill length) of the males and females captured either in spring or autumn. These distinctions are considered below.

Apparent distinctions in a sexual structure of migratory groups on two sites of Sivash are in good accordance with the extent of territorial fidelity of birds, estimated

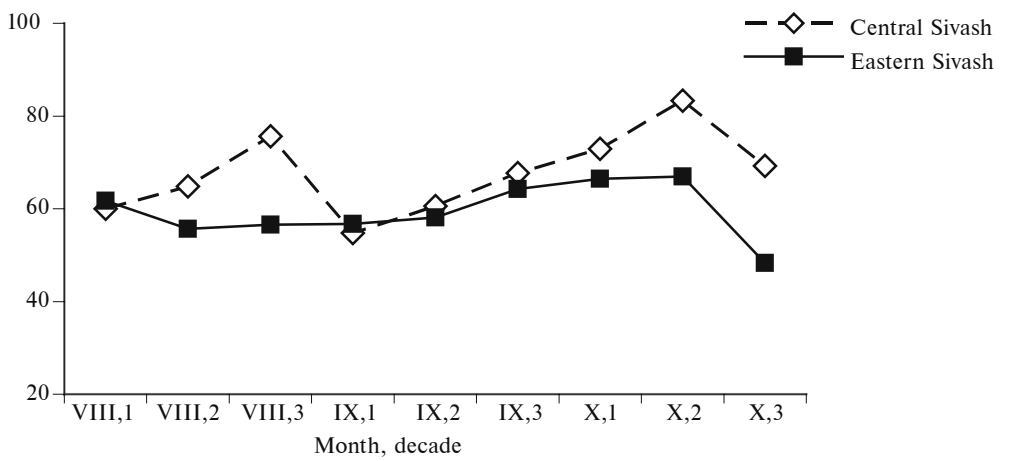


Fig. 3. Changes in the proportion of males among Dunlins captured in autumn on two sites of Sivash.

Рис. 3. Изменение доли самцов среди отловленных осенью чернозобиков на двух участках Сиваша.

by data of recaptures, which is in more detail presented in other publications (Chernichko, 2005). These data prove that the bird exchange between two neighboring sites of Sivash does not exceed 3–5%. In general, such a spatial isolation and distinctions in the sexual structure of two groups give all bases to suggest that the considered sites are essentially different in their ecological characteristics which cause territorial selectivity of Dunlin males and females. More probably, the main ecological distinctions are defined by composition of predominating foraging objects in a macrozoobenthos structure of Central (larvae of chironomids) and Eastern Sivash (polychaete worms), instead of any other reasons (Chernichko, Kirikova, 1999).

Size characteristics of males and females. Size characteristics of the Dunlins caught in different decades were different. Variations of wing and bill size of such a polytypic species as the Dunlin have a strongly pronounced clinal type that complicates definitions of clear borders not only between geographical populations but also between subspecies in general. This is well seen, for example, in a case of recognition or non-recognition of Central Siberian subspecies *C. a. centralis* and also of transitive zones between it and the nominative subspecies *C. a. alpina*, inhabiting tundra of Eastern Europe to Yamal Penisula inclusive (Cramp, Simmons, 1983; Wenink, 1994).

Though many literary sources (Tomkovich, 1984, 1997; Engelmoer, Roselaar, 2000 et al.) describe a gradual increase in body sizes of the Dunlins breeding to the east of Yamal Peninsula, there are possible exceptions of this rule. For example, average wing and bill sizes of males of two subspecies (Engelmoer, Roselaar, 2000) are less different than those of females (table 5). According to the same authors, the males breeding in the section Kanin Peninsula-Yamal Peninsula (that corresponds to the subspecies *C. a. alpina*) have a longer bill than males from Taimyr Peninsula: 32.4 SD = 0.9 (18) and 31.8 SD = 1.5 (24) mm respectively. The males caught by us at nests on Gydan Peninsula in 1989 have a much shorter bill than the birds measured on Taimyr Peninsula (table 5). Perhaps, these distinctions are connected with less number of the measured birds captured on breeding grounds to the west of the Urals, but in general, for the birds nesting to the east of Ural, the tendency of increasing sexual dimorphism in bill length is traced. It is possible to explain in terms of morphological adaptations of Dunlins to more severe conditions of Central Siberian tundra (Tomkovich, 1984 a).

These distinctions in bill length of males belonging to various geographical populations have logically impacted on presentativeness of index of 'wing/bill length' ratio used

**Table 5. Size characteristics of Dunlin males and females from various population groups**
**Таблица 5. Размерные характеристики самцов и самок чернозобика различных популяционных группировок**

| Breeding group/or subspecies | Size characteristics | | | | | | Reference |
|---|---|---|---|---|---|---|---|
| | N | wing, mm | SD | bill, mm | SD | index | |
| Males | | | | | | | |
| Kanin Peninsula-Yamal Peninsula | 18 | 117.1 | 2.1 | 32.4 | 0.9 | **3.61** | Engelmoer, Roselaar, 1998 |
| Taimyr Peninsula | 24 | 117.6 | 1.9 | 31.8 | 1.5 | **3.70** | *ditto* |
| *C. a. alpina* | 50 | 117.4 | 2.4 | 31.5 | 1.7 | **3.73** | *ditto* |
| *C. a. centralis* | 32 | 117.5 | 1.7 | 31.7 | 1.3 | **3.71** | *ditto* |
| Gydan Peninsula, 1989 | 12 | 116.8 | 2.9 | 30.4 | 1.0 | **3.84** | Our data |
| Females | | | | | | | |
| Kanin Peninsula-Yamal Peninsula | 20 | 120.2 | 2.8 | 34.6 | 2.2 | **3.47** | Engelmoer, Roselaar, 1998 |
| Taimyr Peninsula | 13 | 120.8 | 2 | 36.4 | 1.3 | **3.32** | *ditto* |
| *C. a. alpina* | 47 | 120.2 | 2.4 | 34.5 | 1.8 | **3.48** | *ditto* |
| *C. a. centralis* | 16 | 121.3 | 1.7 | 36.5 | 1.8 | **3.32** | *ditto* |
| Gydan Peninsula, 1989 | 7 | 122.7 | 3.5 | 35.4 | 0.9 | **3.47** | Our data |

Note. SD — standard deviation; Index — value of 'wing/bill length' ratio, calculated by us for all groups.

by us in the work. In this case the index intervals accepted by us (≥ 3.67 for males; ≤ 3.42 for females — see 'Methods') mostly characterize birds of the subspecies *C. a. centralis* and might reject from the analyzed group a part of larger (or 'long-billed') males of *C. a. alpina* (not more than 16%, according to our data obtained for Gydan Peninsula in 1989) and small females (mostly *C. a. alpina*), and also some part of birds of the subspecies *C. a. centralis* (the percentage of rejection of females of this subspecies is impossible to estimate).

Size characteristics of males and females defined by the estimate method, and also those of the Dunlins with unidentified sex were considerably different in various decades both in spring and autumn. It is, first of all, an evidence of replacement of different population groups migrating along the Azov-Black Sea coast of Ukraine (fig. 4). In spite of general fluctuation of values, certain tendencies are traced. For instance, by the end of spring migration at Central Sivash, "long-billed" birds were more frequently caught, both among males and females. At Eastern Sivash this process is similar, but between males and females there are some distinctions in dynamics: dynamics of growth of bill length for females is more uniform per decades, and for males there are recorded sharp spasmodic fluctuations in the beginning of spring, differences of which are statistically reliable. For males at Eastern Sivash the wing length of the caught birds increases synchronous-

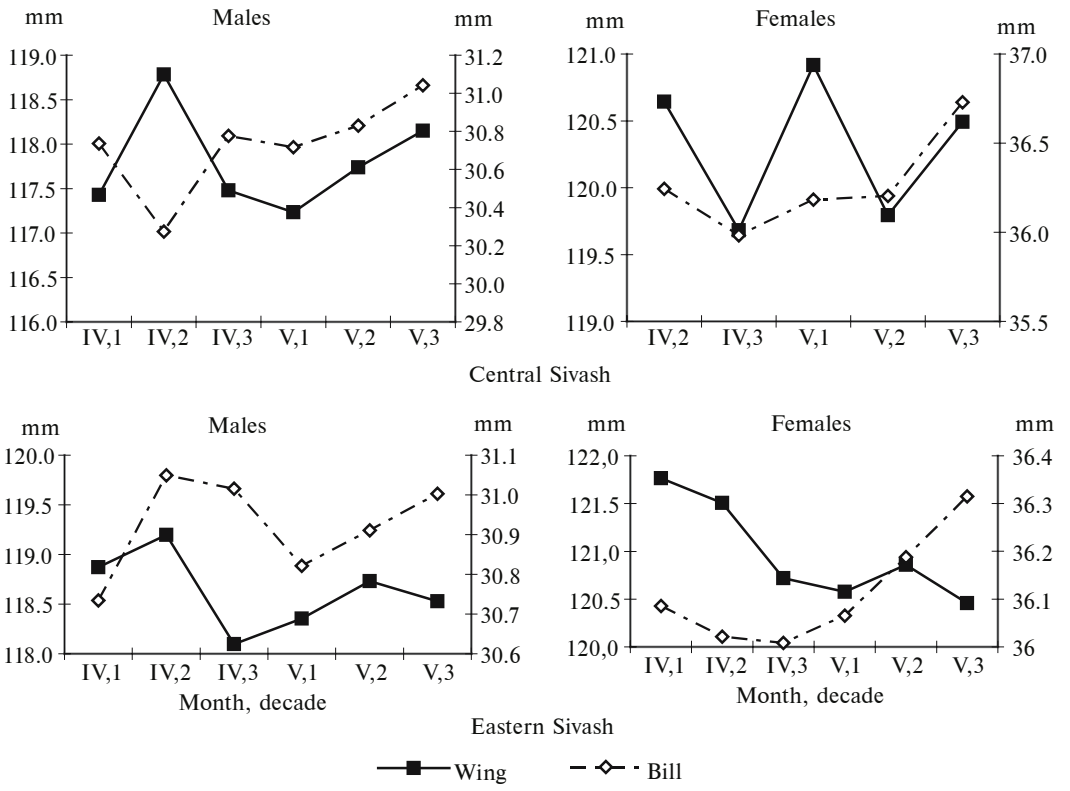


Fig. 4. Dynamics of average values of lengths of bill and wing of Dunlins caught in spring at Central and Eastern Sivash.

Note. Differences in bill length of the males caught in mid-April are reliable (t-value = −3.40; df = 289 and $p < 0.001$), as well as those of the females caught in the third decade of April (t-value = −2.85; df = 120 and $p < 0.005$).

Рис. 4. Динамика средних значений длин клюва и крыла чернозобиков, отловленных весной на Центральном и Восточном Сиваше.

Примечание. Отличия в длине клюва самцов, пойманных в середине апреля от остальных достоверны (t-value = −3,40, при df = 289 и $p < 0,001$), как и самок, отловленных в третьей декаде апреля (t-value = −2,85, при df = 120 и $p < 0,005$).

ly with bill length, and for females an opposite tendency is observed. Spasmodic fluctuations of bill length of males, occurring synchronously at Central and Eastern Sivash in mid-April, can testify the arrival of "short-billed" and, at the same time, "long-winged" males to Central Sivash and, in general, larger males of Dunlins to Eastern Sivash (fig. 4).

Possible differentiation of population groups on stopovers at Sivash is also proved by the fact that average values of bill length for males at Central Sivash in spring are reliably lower than those for the males caught at Eastern Sivash (table 6). For females such differences were not found. It is significant that these differences of bill length between males were already not reliable in autumn; this can be explained by dominance of the subspecies *C. a. centralis* on analyzed sites of Sivash during reverse migrations and by lesser number of the nominative subspecies *C. a. alpina* (longer-winged) due to a loop-like passage of a part of populations in autumn across the Baltic Sea to their wintering grounds in the Mediterranean area (Chernichko, 2006). On the other hand, in autumn both Central and Eastern Sivash show a reliably higher percentage of small-sized males among the captured birds. It is especially noticeable at Eastern Sivash (table 6) which can be explained by the aforementioned suggestion of inter-population differences in the structure of migratory routes.

The qualitative composition of a sample of the birds with sex difficult to identify by the estimate method was also heterogeneous both in time and at different sites of Sivash. Apparent prevalence of males in April at Central Sivash, including that at the expense of representatives of the nominative subspecies, could determine a high frequency of occurrence of "long-billed" birds as it is shown in figure 5, *a*. Simultaneously, an entire time correlation between dynamics of average values of bill length and wing length (fig. 5, *b*) is traced. It can be an indirect proof of a consequential replacement of population groups of Dunlins.

Another indicator is the summarized percent of the birds with unidentified sex among the total sample of the Dunlins captured in spring. Their proportion was already different between two sites of Sivash, but distinctions were especially well-visible when compared with the birds captured at Tiligulsky Liman (fig. 6). There, a high percentage of "long-billed" Dunlins (which can be a feature of males of the nominative subspecies) is in good accordance with distinctions in a structure of the migratory route which lies across the north-western Black Sea area. Compared to Sivash this subregion is crossed on migration with other population groups which is proved by marking of birds (Chernichko, 2000).

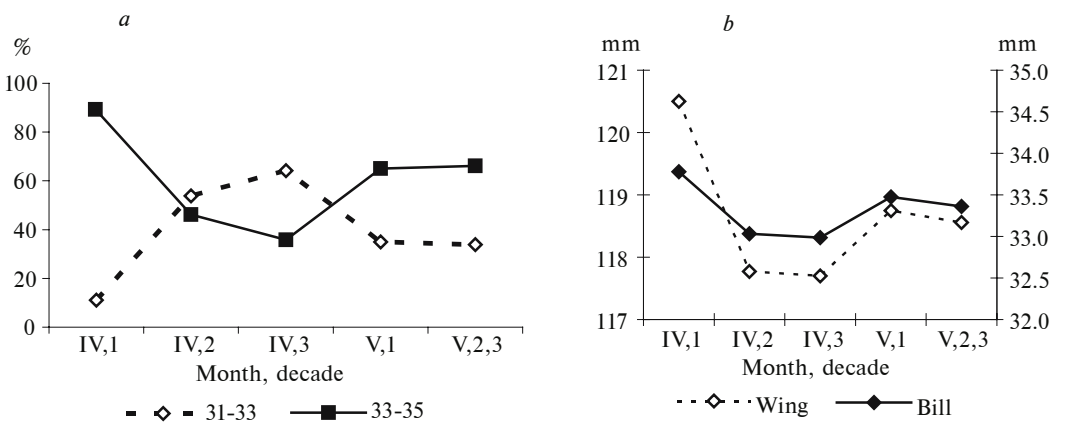


Fig. 5. Change of frequency characteristics of bill length (*a*) and average values of lengths of bill and wing (*b*) for the Dunlins with sex unidentified, caught at Central Sivash in spring.

Рис. 5. Изменение частотных характеристик длины клюва (*a*) и средних значений длин клюва и крыла (*b*) у чернозобиков с неопределенным полом, отловленных на Центральном Сиваше весной.

**Table 6. Comparison of average values of bill length (mm) of the males caught at Central and Eastern Sivash for all the years of research, during different periods of seasonal migrations**

**Таблица 6. Сравнение средних значений длин (мм) клюва самцов, отловленных на Центральном и Восточном Сиваше за все годы, в разные периоды сезонных миграций**

| Compared groups | A | SD | B | SD | t-value | p |
|---|---|---|---|---|---|---|
| Males from Central (A) and Eastern (B) Sivash in spring | 30.7 | 1.2 | 31.0 | 1.3 | −3.24 | 0.001 |
| Males from Central (A) and Eastern (B) Sivash in autumn | 30.5 | 1.1 | 30.6 | 1.2 | −1.21 | 0.225 |
| Males from Central Sivash in spring (A) and autumn (B) | 30.7 | 1.2 | 30.5 | 1.1 | 3.4 | 0.001 |
| Males from Eastern Sivash in spring (A) and autumn (B) | 31.0 | 1.3 | 30.6 | 1.2 | 10.6 | 0.000 |

Note. SD — standard deviation; t — Student's criterion.

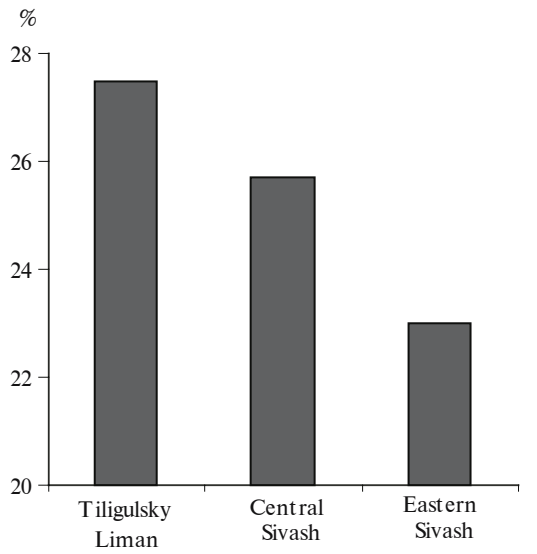


Fig. 6. Percentage of Dunlins with unidentified sex among all the Dunlins caught in spring on different sites of Sivash compared to the birds captured at Tiligulsky Liman.

Рис. 6. Процентный состав чернозобиков с неопределенным полом среди всех отловленных весной на разных участках Сиваша в сравнении с отловленными на Тилигульском лимане.

Essential prevalence of males over females at Central Sivash in spring at the expense of birds from the nominative subspecies could also determine a high proportion of birds with unidentified sex.

In spring, by the end of May, a proportion of birds with unidentified sex at Eastern Sivash dramatically declines (fig. 7). This period is dominated by "long-billed" females completing moult. More likely they represent the subspecies *C. a. centralis*. Less numbers of them occur on both sites of Sivash in autumn, which generally increase the percentage of "average-sized" Dunlins with unidentified sex, but in the first half of August and early October the stopover of birds from eastern population at Sivash for completing their moult is rather probable.

Age composition of migratory Dunlins. Against distinctions in a sexual structure of concentrations of migratory Dunlins on different areas of Sivash the age structure is also interesting.

In spring juvenile Dunlins are distinguished by coloration details of their middle coverts (Gromadska, 1985). At Sivash the percentage of juvenile (underyearling) birds in spring turned out to be much lower than, for instance, on estuaries of the north-western part of the Black Sea or the Sea of Azov, and on average it does not exceed 15%. There are several explanations of this fact. In spring Dunlins of the first calendar year complete the loop-like migratory route from African and Mediterranean wintering grounds across the

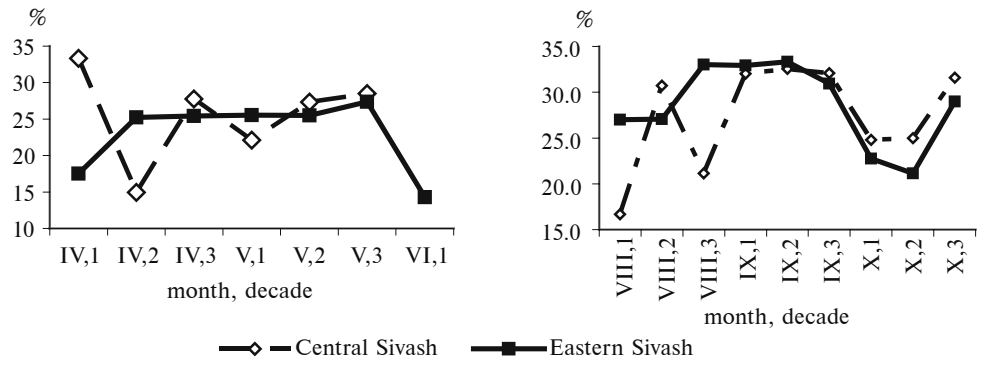


Fig. 7. Dynamics of percentage of Dunlins with unidentified sex among all the Dunlins caught in spring and autumn on two sites of Sivash.

Рис. 7. Динамика состава чернозобиков с неопределенным полом среди всех отловленных весной и осенью на двух участках Сиваша.

western part of Ukrainian seacoast. That is why the proportion of underyearling birds in that region is much higher (Chernichko, 2006). The high percentage of adult birds at Sivash with its rich forage resources is determined by the fact that adult migratory population of Dunlins more frequently use the most optimal habitats for prenuptial moult and gaining initial mass for fat depots.

Distinctions in a percentage composition of underyearling birds among the Dunlins caught in spring at Sivash (16–18%) and Tiligulsky Liman (30%) are statistically reliable (Student's t-criterion = 3.30; df = 24; $p < 0.003$); at the same time they are not reliable between sites of Sivash. These proportions keep the same value also in the period of autumn migrations (table 7), though the percentage of yearling birds is noticeably lower, which is especially well seen at the example of Sivash.

Complete comparison of autumn migrations between Sivash and Tiligulsky Liman is complicated because captures on the liman were carried out at the very beginning of autumn migrations. This fact had an impact on a low percentage of males (47.5%), which on migration follow females who are the first to leave breeding grounds in tundra. It might also influence on the proportion of yearling birds in the beginning of the migratory period. Anyway, differences in the total percentage of yearling birds have also caused essential differences in the proportion of males among this age group. In this case Central Sivash has also shown the presence of spatial differentiation of sexual groups among yearling birds (table 7). Such distinctions between Central and Eastern Sivash were the sharpest during autumn migrations (73.3 and 56.8%, respectively). In autumn the proportion of yearling males was significantly lower on Tiligulsky Liman as well.

**Table. 7. Differences in the percentage of various age groups among Dunlins, caught at Central Sivash (A), Eastern Sivash (B) and Tiligulsky Liman (C) during spring and autumn migrations**

**Таблица 7. Различия в процентном соотношении разных возрастных групп чернозобиков, среди отловленных на Центральном Сиваше (A), Восточном Сиваше (B) и Тилигульском лимане (C) во время весенних и осенних миграций**

| Season | Age group | A | B | C | A | B | C |
|---|---|---|---|---|---|---|---|
| | | Total | | | Of them males | | |
| Spring | Adults | 81.5 | 83.6 | 70.0 | 59.2 | 56.0 | 52.6 |
| | Underyearlings | 18.5 | 16.4 | 30.0 | 59.0 | 46.3 | 64.2 |
| Autumn | Adults | 80.7 | 80.9 | 86.7 | 64.3 | 60.0 | 47.5 |
| | Yearlings | 2.3 | 2.3 | 13.3 | 73.3 | 56.8 | 33.3 |
| | Juveniles | 17.1 | 16.8 | ? | 58.0 | 56.5 | ? |

## Conclusion

Spatial differentiation of "male" groups of some populations of Dunlins is connected with differences in composition of forage macrozoobenthos on two sites of Sivash. For males it is more profitable to feed on larvae of chironomids in surface layers of mud at Central Sivash, while "longer-billed" females prefer feeding on polychaete worms at Eastern Sivash. Such situation is possible (and useful) only in case of vast areas of feeding territories which is true for Sivash sites. As for Black Sea estuaries such a differentiation is absent. Duration of stopovers of different sexual groups, and also of different populations could also have and impact on the extent of territorial fidelity in the structure of migratory ways.

It can be suggested that the same ecological reasons determine differences in the percentage of different population groups distinguished by average values of bill length. Differences in age structure of migratory groups and population belongingness of Dunlins are also connected with features of the structure of migratory routes in spring and autumn in western and eastern parts of the Azov-Black coast of Ukraine. In western part of the region in spring migratory Dunlins are characterized by a higher percentage of the subspecies *C. a. alpina*, percentage of underyearling birds is also higher, while in the eastern part of the region it is the subspecies *C. a. centralis*, which has a higher percentage. In autumn this situation is similar but more smoothed because of bird inflow from the nominative subspecies following the Baltic-Black Sea migratory corridor.

Preliminarily, a scheme of replacement of groups of migratory Dunlins is the following: the first migrants in spring are males of *C. a. alpina*, followed by males of *C. a. centralis* and females of both subspecies. Males of the nominative subspecies start to leave feeding areas, having completed prenuptial moult, in late April-early May. The last to depart from feeding areas of Sivash are females of the subspecies *C. a. centralis.*

In autumn the females which left their broods (more likely the subspecies *C. a. centralis*) are the first to arrive to the Black Sea coast. Then females and males of the nominative subspecies arrive. The males and majority of females of the subspecies *C. a. centralis* are the last to arrive, partly together with juvenile Dunlins or before a peak of their arrival. The discovered regularities are typical for Sivash where a significant part of population of both subspecies of Dunlins migrates (Chernichko et al., 1991). As for other stopover sites, the percentage of different sex and age groups there can be different and requires further investigation.

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