Herring Gull *Larus argentatus* Pont. and Great Black-backed Gull *Larus marinus* L. haematology as a tool in bioindication

By Christiane Averbeck

Introduction

Gulls are regularly used as bioindicators for environmental pollution (BECKER et al. 1980, OELKE & RÜSSEL 1980, LEIGHTON et al. 1985, HARTWIG et al. 1990). Gulls are widely distributed and occupy a position towards the upper end of the food web. Even low material contamination levels can be detected relatively early wherever they are prone to accumulate (ARNDT et al. 1987). Sofar kidney, liver, muscle, stomach and intestines contents, feathers and eggs have been used to determine pollution levels (BECKER et al. 1980, SCHREY 1980, VAUK 1982, LEIGHTON et al. 1985, KÖTH & VAUK-HENTZELT 1988). These measurements are mostly taken postmortum. The need is apparent for a more accurate and sophisticated system of measurement to identify acute and chronic disorders. Haematological parameters may serve to provide such a system. The blood is capable of reaching almost every part of the body. This accounts for its particular significance in checking the general clinical condition of an organism (ARCHER 1977).

Man is the only species which has been thoroughly and systematically studied with respect to its haematology. In the bird literature one finds mainly papers on the blood of domestic fowl (LUCAS & JAMROZ 1961, MEHNER & HARTFIEL 1983, STURKIE 1986). Information on the blood of non-domestic birds that were examined came in most cases from captive birds, including gulls (KOLB 1958, CHRISTOPH & BOROWSKI 1961, CHRISTOPH & TRAUE 1961, CHRISTOPH & FRANK 1965, GERLACH et al. 1978, HÜPPOP 1988).

The haematology of wild birds has never been studied throughout a complete annual cycle. Yet compared to birds held in captivity, wild birds are more influenced by a changing environment such as seasonal light and temperature fluctuations (GWINNER 1975, GRAW et al. 1979, STURKIE 1986). Consequently life functions such as reproduction, nesting, moult and migration respond more readily to seasonal changes than in domestic animals.

The aim of this paper is to establish standard reference values for the red blood cell picture in healthy Herring Gulls *Larus argentatus* and Great Black-backed Gulls *Larus marinus* according to sex, age and time of year and to compare them with clinically abnormal birds of both species.

Material and Methods

Between November 1986 and December 1987, I examined 166 Herring Gulls (90 ♀, 76 ♂) and 78 Great Black-backed Gulls (43 ♀, 35 ♂).

The birds were shot, trapped or dazzled by lamps at night during gull control measures on Helgoland (VAUK 1982). In order to eliminate the effects of daily cycle in the haematological parameters the birds were killed between 11.00 and 13.00 hrs. Immediately after death (either by shooting or a heavy blow on the head) the thoracic cavity was opened and blood was sampled from the atrium. To prevent coagulation, the blood was syphoned into tubes containing EDTA. After blood sampling, sex, mass and age of the birds were determined. On basis of the plumage birds were classified as nestlings, 3–6 months old, 1, 2, 3, 4 year old and adult. It was noted whether or not the birds were clinically normal. Those noted as sick were either oiled, emaciated, infested with an obvious large number of parasites or had external injuries or evident organic abnormalities. I did not carry out a precise veterinary diagnosis.

Blood was analysed within 3 hours after sampling. Erythrocytes were stained and counted in a NEUBAUER counting chamber (NATT & HERRICK 1952), yielding the red blood cell count (RBC). Haemoglobin content (Hb) was measured photometrically using the cyanmethaemoglobin method (BAYER DIAGNOSTIK, München). The packed cell volume (PCV) was determinated using a standard microhaematocrit centrifuge (BAYER DIAGNOSTIK, München). The mean cell volume (MCV), the mean cell haemoglobin concentration (MCHC) and the mean cell haemoglobin (MCH) were calculated using standard formulae (RICK 1977).

Student-T-statistics for two means was used to demonstrate significant differences. If there were no significant differences between species, sexes and ages the corresponding groups tested by the Student-T-statistics were summarized (Table 1). ANOVA was used for testing each bloodparameter in relation to time of the year, clinical state and capturing method (*: $p < 0.05$, **: $p < 0.01$, ***: $p < 0.001$).

Results

No significant differences in the parameters studied were found between clinically normal Herring Gulls and Great Black-backed Gulls (Table 1). Moreover in neither of the two species differences between sexes could be established. With the exception of Herring Gull nestlings, the various age groups also yielded the same results (Table 1). Evidently the birds reach haematological maturity at fledging (HODGES 1977). Herring Gull nestlings had lower RBS, PCV, haemoglobin and MCHC values and thus were anaemic compared with more mature birds of this species. Their red cells were larger.

RBS significantly ($p < 0.01$) dropped from November–December to January–February and showed a significant ($p < 0.01$) rise in March (Fig. 1). The PCV of Herring Gulls and Great Black-backed Gulls remained unchanged during the annual cycle. Haemoglobin content increased ($p < 0.05$) in January and decreased again in February. For MCV ($p < 0.05$) and MCHC ($p < 0.001$) a rise from December to January–February was found. Like the PCV the MCHC remained unchanged during the annual cycle.

The mean values of RBC of trapped gulls (1.9×10^{12}/l) are lower than those of shot gulls (2.1×10^{12}/l; $p < 0.05$). This could be related with the masses, which are also lower in the case of trapped gulls (1084.1 g compared to 1201.1 g of shot gulls; $p < 0.05$). But there is no significant relation between body masses of trapped or shot gulls and RBC.

Since no significant differences were established between the species, sexes and fledged age groups, it was possible to set all the clinically normal gulls against those with clinical abnormalities. Irrespective of seasonal fluctuations in the parameters, there were significant ($p < 0.001$) differences discovered between clinically normal and clinically abnormal Herring Gulls and Great Black-backed Gulls (Table 1). The pathological condition of the birds examined was associated with a reduction in the levels of the RBC, PCV, haemoglobin content. There were no significant differences between clinical normal and clinical abnormal gulls concerning MCH, MCV and MCHC (Table 1).

Discussion

Haematological parameters in birds are known to fluctuate in relation to factors such as species, age, sex, state of health and nourishment, habitat, height above sea-level, hormone balance and season (KEYS et al. 1986, STURKIE 1986, HÜPPOP 1988).

Red cell values in the Herring and Great Black-backed Gulls examined were generally similar to those described elsewhere (Table 2). Only the values marked with an asterisk are apparently different to those of my own examination. The wide ranges in haematological results are pos-

Table 1: Haematological parameters (Mean ± SD, range und sample size) in clinically normal and abnormal full grown Herring Gulls (HG) and Great Black-backed Gulls (GBG) and in nestling Herring Gulls. *** p<0.001, ** p<0.01, means differ significantly from the means of clinically normal full grown Gulls.

Tab. 1: Hämatologische Parameter ($\bar{x}$ ± SD, Varianz, Probengröße) von klinisch normalen und klinisch anormalen ausgewachsenen Silbermöwen (HG) und Mantelmöwen (GBG) und Silbermöwennestlingen

parameter	clinically normal		clinically abnormal	nestling
	HG	GBG	HG + GBG	HG
RBC [x 10^{12}/l]	2.1 ± 0.3 (1.3 – 3.2; 143)	2.1 ± 0.4 (1.4 – 3.1; 57)	1.7 ± 0.3*** (0.9 – 3.5; 28)	1.5 ± 0.4*** (1.1 – 1.9; 24)
PCV [l/l]	0.41 ± 0.01 (0.32 – 0.54; 109)	0.41 ± 0.01 (0.38 – 0.50; 46)	0.33 ± 0.01*** (0.10 – 0.55; 28)	0.35 ± 0.04*** (0.26 – 0.42; 24)
Hb [g/dl]	13.0 ± 1.9 (8.5 – 17.8; 109)	12.9 ± 1.7 (10.3 – 16.5; 46)	10.6 ± 2.5*** (4.0 – 17.8; 28)	9.9 ± 1.3*** (7.0 – 12.5; 24)
MCV [fl]	200.6 ± 36 (120.0 – 317.7; 109)	200.3 ± 35.5 (142.4 – 270.2; 46)	195.9 ± 48.2 (142.9 – 350.0; 28)	242.9 ± 44.0*** (180.9 – 317.7; 24)
MCHC [g/dl]	31.5 ± 3.3 (25.0 – 39.3; 109)	31.5 ± 2.2 (25.0 – 37.5; 46)	33.9 ± 9.1 (28.1 – 103.4; 28)	28.4 ± 2.2** (25.0 – 30.9; 24)
MCH [pg]	62.7 ± 10.0 (40.6 – 97.8; 109)	63.2 ± 10.7 (40.2 – 97.6; 46)	59.2 ± 6.2 (40.0 – 97.8; 28)	68.6 ± 11.3*** (55.9 – 84.1; 24)

sibly attributable to individual fluctuations, differences in the prevailing experimental conditions, the types of blood sample, it's preparation and to the clinical condition and state of nourishment of the birds. Thus GROEBBELS (1932), CHRISTOPH & TRAUE (1961) and VISCOR et al. (1984) arrive at three different figures for the RBC of caged Black-headed Gulls *Larus ridibundus*: 2.67, 3.285 and 3.86 x 10^{12}/l. The figures given for the sex-specific differences in blood parameters in birds vary greatly from species to species. There are reports on species where there is no difference between males and females and also species which show unequivocal disparities between the sexes (HODGES 1977, MEHNER & HARTFIEL 1983, GERLACH et al. 1984).

Lower red cell values in nestlings than in full-grown birds were also found by BENNETT & CHISHOLM (1964) and LEIGHTON et al. (1985) (Table 2).

In a study of three caged Herring Gulls HÜPPOP (1988) recorded the lowest RBC and haemoglobin content in August and the highest in November–February. This led him to conclude that RBC and haemoglobin content in gulls are dependent on ambient temperatures, with low ambient temperatures causing a rise in RBC and haemoglobin. High RBC's are connected with an amplified oxygen carrying facility of the blood and with the reduction of heat loss during breathing (HÜPPOP 1988). This conclusion is confirmed by MOYE et al. (1969), who examined the haematology of domestic fowl *Gallus gallus domesticus* housed for 60 days in climatic chambers at temperatures of 8°C and 30°C. The low RBC and haemoglobin levels found by me in winter (Fig. 1) are in disagreement with the results of HÜPPOP (1988) and MOYE et al. (1969). An explanation for the relatively

Table 2: Comparison of haematological findings in Herring Gulls and Great Black-backed Gulls. [1] [° nSh], [2] [g%], [3] [g/dl].

Tab. 2: Hämatologische Befunde von Silber- und Mantelmöwen

source	species	n	age	RBC [x 10^{12}/l]	PCV [l/l]	Hb	MCHC [g/dl]
GROEBBELS (1932)	Great Black-backed Gull	?	?	3.36	–	–	–
CHRISTOPH & TRAUE (1961)	Herring Gull	18	?	2.1	–	90.25[1]	–
BENNETT & CHISHOLM (1964)	Herring Gull	10	immat.	–	0.28 – 0.36	–	–
CLAUSEN et al. (1971)	Herring Gull	6	?	2.2 – 3.1	0.43 – 0.55	116 – 135[2]	–
LEIGHTON et al. (1985)	Herring Gull	?	nestling	–	0.30	7.8[3]	–
HÜPPOP (1988)	Herring Gull	4	?	2.5 – 3.7	–	10.8 – 15.0[3]	33 – 49
AVERBECK	Herring Gull Herring Gull Great Black-backed Gull	24 109 46	nestling full grown full grown	1.5 2.1 2.1	0.35 0.41 0.41	9.9[3] 13.0[3] 12.9[3]	28.4 31.5 31.5

low RBC level in January–February and the high MCH levels in January–February are perhaps attributable to the gull's poor state of nourishment in those months (see PRÜTER 1984). Since MCV, MCHC and MCH are functions of RBC, PCV and haemoglobin content, the seasonal fluctuations of these parameters can be attributed to the same causes.

The gulls examined in January–February comprised more or less equal numbers of shot and baited birds. In the other months over 90% of the birds had been shot. Conceivably gulls driven by hunger are more easily lured into a trap baited by food. Probably in this situation, the undernourishment of these birds living in the wild had a greater effect on their haematology than the lowest temperatures (in 1987 on Helgoland in January–February). In opposition to this hypothesis there is no significant relation between the RBC and the body masses of captured or shot gulls.

This study shows that healthy birds are haematologically distinguishable from sick birds. Like in human medicine it is useful to consider several blood parameters for the analysis of the health condition of birds. Since sick birds were not veterinary examined it is not possible to attribute the changes in parameter values to particular pathological condition. However studies carried out on flamingos by HAWKEY et al. (1984, 1985) show that changes in the red cell values can occur as a consequence of inflammation, infection, fractures etc. And LEIGHTON et al. (1985) describe a fall in RBC, PCV and haemoglobin content in Herring Gull nestlings after having ingested oil.

Haematological studies are a promising field for the study of population pathology, as other authors confirm (HAWKEY et al. 1984, 1985, DOBSINSKY & DOBSINSKA 1976, GERLACH et al. 1984, LEIGHTON et al. 1985). Tests can be repeated, the results are accurate and the parameters are highly responsive. Moreover, there is no need for killing the birds as it is possible to sample enough blood for the diagnosis from the *vena cutanea ulnaris* without harming the bird.

It would be interesting to kill those gulls shown by the haematological tests to be sick and to test them for various toxins. This would make it possible to study interrelationships between abnormal haematological findings and contamination with toxins.

Acknowledgements

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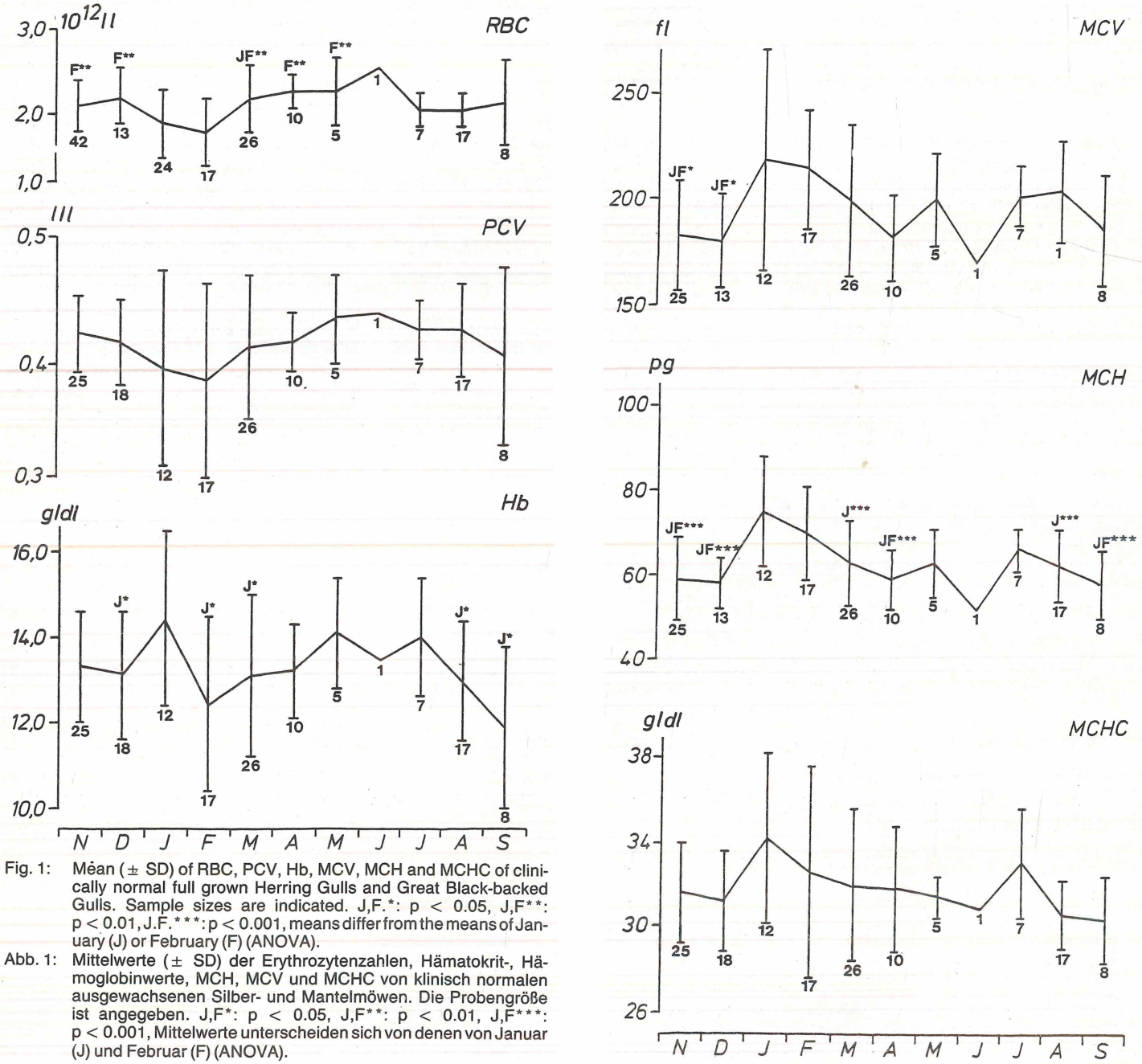
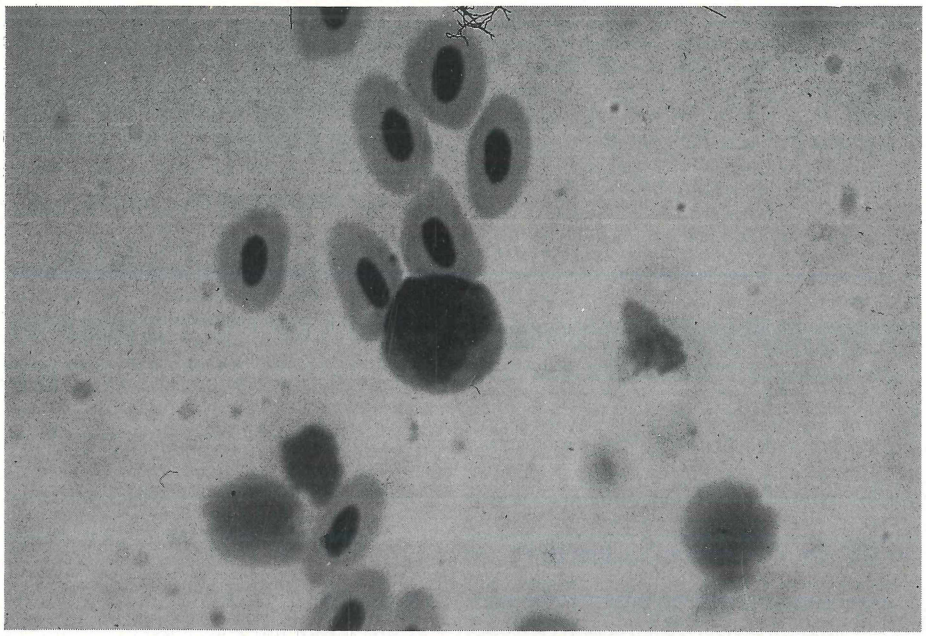


Fig. 1: Mean (± SD) of RBC, PCV, Hb, MCV, MCH and MCHC of clinically normal full grown Herring Gulls and Great Black-backed Gulls. Sample sizes are indicated. J,F.*: $p < 0.05$, J,F**: $p < 0.01$, J.F.***: $p < 0.001$, means differ from the means of January (J) or February (F) (ANOVA).

Abb. 1: Mittelwerte (± SD) der Erythrozytenzahlen, Hämatokrit-, Hämoglobinwerte, MCH, MCV und MCHC von klinisch normalen ausgewachsenen Silber- und Mantelmöwen. Die Probengröße ist angegeben. J,F*: $p < 0.05$, J,F**: $p < 0.01$, J,F***: $p < 0.001$, Mittelwerte unterscheiden sich von denen von Januar (J) und Februar (F) (ANOVA).

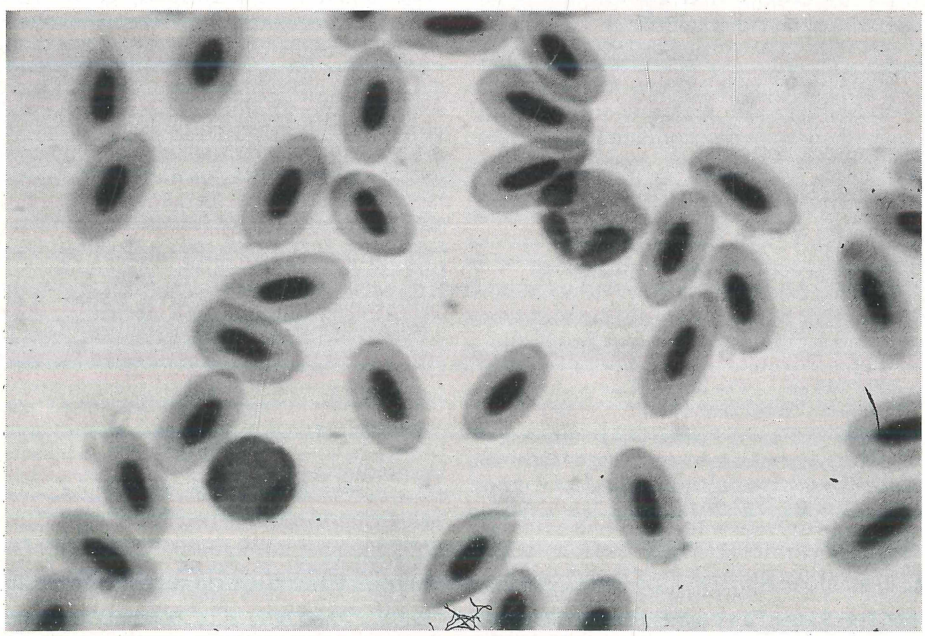


Erythrocytes (oval shaped) and Monocyte (round shaped) of an adult Herring Gull.
Erythrozyten (ovale Form) und Monozyt (runde Form) einer adulten Silbermöwe.
Foto: Averbeck

goland and completed at the Norddeutsche Naturschutzakademie. I wish to extend my thanks to Prof. Dr. Vauk and to Prof. Dr. Fischer for their supervision of the study, to the »Verein der Freunde und Förderer der Vogelwarte Helgoland« for their financial support, to C. Hawkey, U. Sancken and M. Klaasen for useful comments on the manuscript and to K. Wilson and Dr. W. Marquard for their help with the English.

Summary

Over a period of 12 months red blood cell count (RBC), packed cell volume (PCV), haemoglobin content (Hb), mean cell volume (MCV), mean cell haemoglobin concentration (MCHC), mean cell haemoglobin (MCH) for Herring Gulls and Great Black-backed Gulls shot or trapped on Helgoland, German Bight, were studied. Comparisons were made between species, sexes and age groups and clinically normal and abnormal birds. No differences in parameters were found between species and sexes. The only significant age dependency was found between nestlings and fledged birds. RBC were lowest and MCH and MCV highest in mid-winder. Haemoglobin content were highest in January and lowest in February. The low RBC and high MCH and MCV values may be the result of the poor state of nourishment of the trapped gulls. There were appreciable differences between healthy and sick animals independent of seasonal fluctuations. This suggest that, blood parameters have diagnostic value which can broaden the range of use of gulls as bioindicators.



Erythrocytes (oval shaped) and Granulocytes (round shaped) of an adult Herring Gull.
Erythrozyten (ovale Form) und Granulozyten (runde Form) einer adulten Silbermöwe.
Foto: Averbeck

Zusammenfassung

Über einen Zeitraum von 12 Monaten wurde die Erythrozytenzahl (RBC), der Hämatokrit (PCV), der Hämoglobingehalt (Hb), das Mittlere korpuskuläre Volumen (MCV), die Mittlere korpuskuläre Hämoglobinkonzentration (MCHC) und das Mittlere zelluläre Hämoglobin (MCH) von auf Helgoland gefangenen und geschossenen Silbermöwen und Mantelmöwen untersucht. Die Werte wurden hinsichtlich Artzugehörigkeit, Geschlecht, Altersgruppe und Gesundheitszustand der Vögel betrachtet. Saisonale Schwankungen wurden ebenfalls berücksichtigt. Zwischen den Arten und Geschlechtern wurden keine Unterschiede gefunden. Der einzige signifikante Unterschied das Alter betreffend, konnte zwischen Nestlingen und flüggen Vögeln festgestellt werden. Mitte des Winters waren die Erythrozytenzahlen am niedrigsten und das MCH und MCV am höchsten. Beim Hämoglobingehalt konnten die höchsten Werte im Januar und die niedrigsten im Februar gemessen werden. Die niedrige Erythrozytenzahl und die hohen MCH und MCV Werte könnten auf den schlechten Ernährungszustand der gefangenen Möwen zurückzuführen sein. Es war möglich, Unterschiede zwischen gesunden und kranken Möwen unabhängig von saisonalen Schwankungen zu messen. Zusammen mit anderen Feststellungen führen diese Ergebnisse zu der berechtigten Annahme, daß Blutparameter einen diagnostischen Wert haben, der die Funktion der Möwe als Bioindikator verbessert.

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Band 7, Teil 1: Bibliographie der deutschsprachigen ornithologischen Periodika Mitteleuropas

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Von der Avifauna Baden-Württembergs, die auf sieben Bände ausgelegt ist, sind bisher Band 1 mit drei Teilen, Band 4 sowie der erste Teil des Band 7 erschienen, der eine Bibliographie der deutschsprachigen ornithologischen Periodika in Mitteleuropa enthält. Insgesamt soll der Band 7 aus vier Teilen bestehen, wobei der Teil 2 eine Bibliographie der ornithologischen Periodika der Welt, Teil 3 eine Bibliographie aller deutschsprachigen Avifaunen und Teil 4 eine vollständige Bibliographie der ornithologischen Literatur Baden-Württembergs enthalten soll. - Im vorliegenden Buch beschreibt der Autor in drei Einleitungskapiteln den Aufbau der Bibliographie, geschichtliche Aspekte der ornithologischen Periodika und Wünsche und Empfehlungen für die Herausgabe von ornithologischen Periodika. Im vierten Kapitel werden dann die vollständigen bibliographischen Daten aller erschienenen Bände von 851 Fachzeitschriften auf dem Gebiet der Vogelkunde von der ersten ornithologischen Zeitschrift »Ornis« 1824 bis heute in alphabetischer Reihenfolge vorgestellt. Zu jedem Titel finden sich die notwendigen Informationen, z. B. Titel, Untertitel, bibliographische Angaben und Hinweise zur thematischen Einstufung. 241 Abbildungen von Titelblättern einzelner Zeitschriften lockern die Auflistung auf. - Der vorliegende erste Teil des Bibliographie-Bandes 7 ist die erste umfassende deutschsprachige Zeitschriften-Fachbibliographie auf dem Gebiet der Ornithologie. Sie ist hervorragend gestaltet, erleichtert das Recherchieren bereits veröffentlichter Arbeiten außerordentlich und ist auch noch preiswert. Ungewöhnlich ist nur, daß sie innerhalb einer regionalen Avifauna erscheint. Eine separate Veröffentlichung ohne Bindung an die Avifauna Baden-Württembergs wäre dem Verlag zu raten gewesen, damit diese wichtige Bibliographie nicht in der gegenwärtigen Plazierung untergeht.

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