HYDROBIOLOGICAL BULLETIN 17(2): 119 - 127 (1983)

ECOLOGICAL AND MORPHOLOGICAL OBSERVATIONS ON *HYDROBIUS NIGER* (ZSCHACH, 1788) AND *HYDROBIUS FUSCIPES* (LINNAEUS, 1758) (COLEOPTERA, HYDROPHILIDAE).

TH. G. GIESEN

INTRODUCTION

According to BALFOUR - BROWNE (1958) the genus *Hydrobius* is represented by two species in Europe, *Hydrobius fuscipes* (Linnaeus, 1758) and *Hydrobius niger* (Zschach, 1788; = *Limnoxenus niger* (Zschach)).

The variable intensity of the elytral punctured striae is used as an identification character. The elytral striae of *H.fuscipes* are distinct and deepening towards the apices. *H.niger* has no definite striae but rows of fine punctures (BALFOUR - BROWNE, 1958; Fig. 1). The mesosternal pointed projection of *H.fuscipes* is a projecting keel in *H.niger* (Fig. 1.5 and 1.10). The maxillary palpi of *H.fuscipes* are yellowish with a dark tip, in contrast with *H.niger* of which the maxillary palpi are black (Fig. 1.2 and 1.7).

The ♂ and ♀ genital armature of both species have been given in Fig. 2. The oval shaped transparent region on the inner face of the spinnerets appears to be more obvious in ♀♀ of *H.fuscipes* (Fig. 2). BALFOUR - BROWNE (1910) could not find any pores in this region and concluded that the ducts of the silk glands open elsewhere.

Though morphological differences are obvious, habitat preference is unclear. According to BALFOUR - BROWNE (1958, 1962) *H.niger* is a brackish water species, with a few outlying colonies in fresh or peaty waters, in England. *H.fuscipes* is called a freshwater species. Both beetles are well - flying species (JACKSON, 1956; BALFOUR - BROWNE, 1958; DETTNER, 1976). OBRTEL (1972) caught *H.fuscipes* in pitfall traps in drained reed swamps. *H.fuscipes* chiefly feeds on filamentous and epiphytic algae, but on dead insect larvae and snails as well (BALFOUR - BROWNE, 1910). Beside these characters little is known about the habitat preference.

A hydrobiological investigation in the polder 'Midden - Delfland' (Province of Zuid - Holland, The Netherlands), in the summer of 1980, offered an opportunity to compare the distribution of *H.niger* and *H.fuscipes* in localities of similar morphogenesis in a rather small area (6600 ha = 16302 acres). Chemical characteristics of the water and vegetation structure as well as the number of species of Coleoptera, Heteroptera and Mollusca have been recorded.

MATERIALS AND METHODS

The beetles were collected in July, August and September 1980 (for the exact data see Table 3). The sampling procedure was similar to that described by DETTNER (1976). At each locality, all microhabitats were sampled until no new macroscopically identifiable species were found. So the number of individuals is not standardized.

Table 1. c-values of the structural groups used in the 'Vegetation Index' with some examples of macrophytes for each group.

No.	Structural group	Macrophytes	c-value
1.	Lemnaceae	*Lemna, Spirodela, Wolffia, Azolla* spec.	1
	With percentage covering more than 50 %		0.5
2.	Emergent macrophytes	*Glyceria, Alisma, Juncus, Oenanthe* spec.	1
3.	Emergent macrophytes	*Equisetum, Hippuris* spec.	2
4.	Macrophytes with floating leaves, not anchored by roots	*Hydrocharis* spec.	2
5.	Macrophytes with floating leaves, anchored by roots	*Nymphoides, Potamogeton, Polygonum, Callitriche* spec.	2
6.	Linearly leaved submerged macrophytes	*Potamogeton, Zannichellia, Elodea* spec.	4
7.	Free floating macrophytes	*Lemna trisulca, Riccia* spec.	8
8.	Finely divided, submerged macrophytes	*Myriophyllum, Ceratophyllum, Chara* spec.	10
9.	Coarsely divided, submerged macrophytes	*Potamogeton lucens, P.crispus, P.densus*	6
10.	Filamentous algae		2

Table 2. Minimum, maximum and mean values of some chemical parameters at localities of *Hydrobius niger* and *H.fuscipes*. TOC = Total Organic Carbon.

parameter	*H.niger*			*H.fuscipes*		
	min.	max.	mean	min.	max.	mean
pH	6.2	7.9	7.1	6.4	8.3	7.1
TOC ($mg.l^{-1}C$)	7	48	28	8	90	30
Alkalinity ($m.eq.l^{-1}$)	3.5	5.8	4.7	3.6	5.7	4.9
SO_4^{2-} ($mg.l^{-1}$)	161.5	221.0	191.8	84.6	192.2	164.6
$NO_2^- + NO_3^-$ ($mg.l^{-1}$)	0	0.7	0.3	0	14.7	3.2
NH_4^+ ($mg.l^{-1}$)	0	1.1	0.2	0	0.4	0.1
PO_4^{3-} ($mg.l^{-1}$)	0.9	9.0	3.5	0.4	7.7	4.0
Mg^{2+} ($mg.l^{-1}$)	16.3	25.0	22.0	15.3	24.1	19.3
K^+ ($mg.l^{-1}$)	11.7	35.2	19.6	3.9	31.3	15.6
Ca^{2+} ($mg.l^{-1}$)	36.1	48.1	40.1	28.1	64.6	44.1

Chemical parameters (NH_4^+, K^+, Na^+, Ca^{2+}, Mg^{2+}, Mn, Fe, Cl^-, PO_4^{3-}, SO_4^{2-}, $NO_2^- + NO_3^-$, alkalinity, pH and Total Organic Carbon) of the water (filtered over a Whatman glassfilter GF/C, 3 μm) as well as abiotic characters of the habitat (waterdepth,

width of the ditch, angle between the shore and the water surface, soiltype, Secchi-transparency) were determined per locality.

The diversity number of the vegetation after DE LANGE and VAN ZON (1978) was calculated and the width of the border vegetation (emergent macrophytes) was estimated. A so called 'Vegetation Index' of the vegetation was calculated using the formula

$$\sum_{i=1}^{n} \left(\frac{B.H}{W} .c \right) i$$

in which

B = the percentage cover per species
H = the vertical cover per species in cm
W = the waterdepth in cm
c = the constant value per structural group (Table 1) to which the species belongs
n = the number of species
i = the i^{th} species.

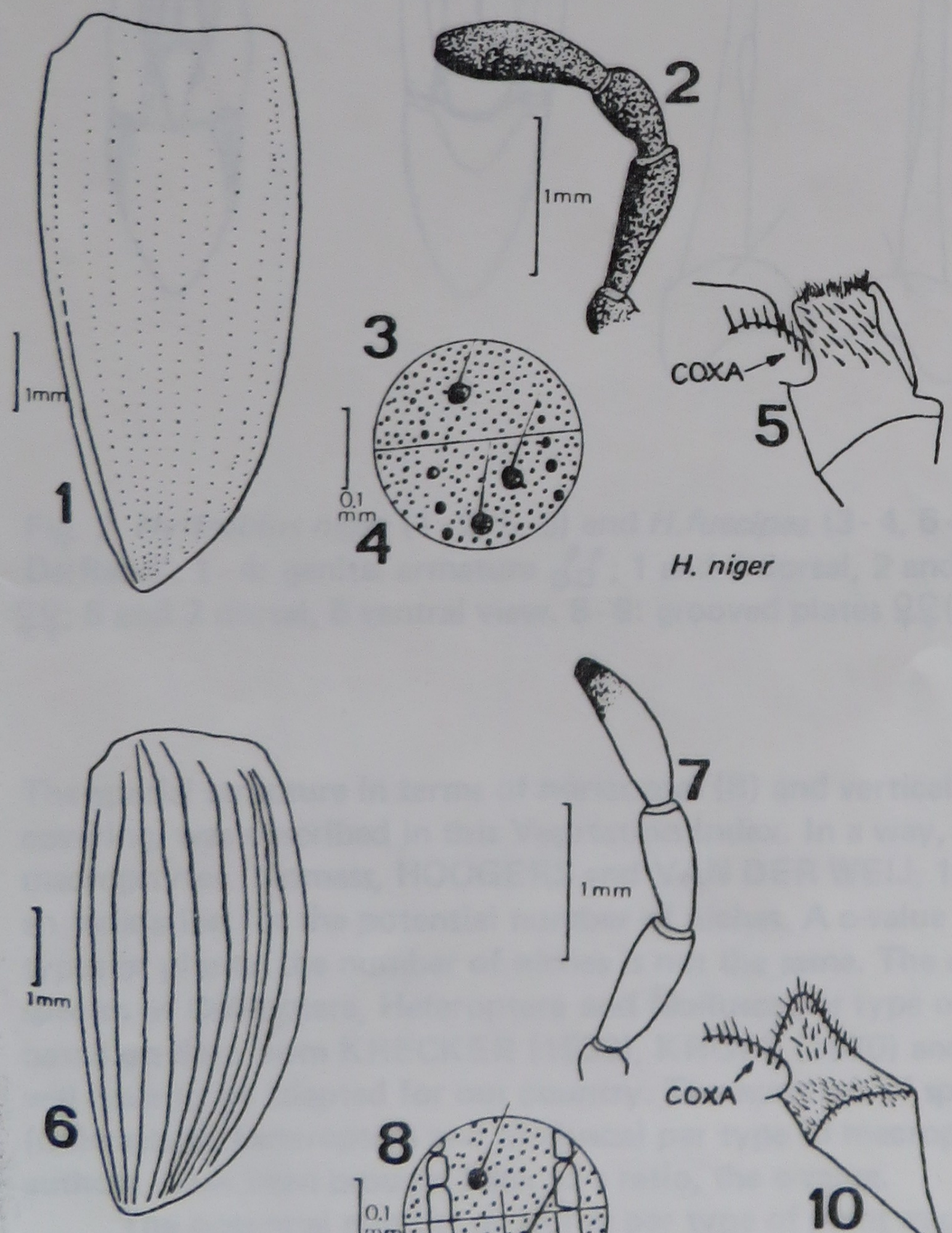

Fig. 1. Morphological characters of *Hydrobius niger* (1 - 5) and *H. fuscipes* (6 - 10) from localities in 'Midden - Delfland'. 1 and 6: elytra, schematically; 2 and 7: maxillary palpi; 3 and 8: apical elytral striae and puncturing; 4 and 9: caudal elytral striae and puncturing; 5 and 10: mesosternal projection between fore and mid legs, lateral view.

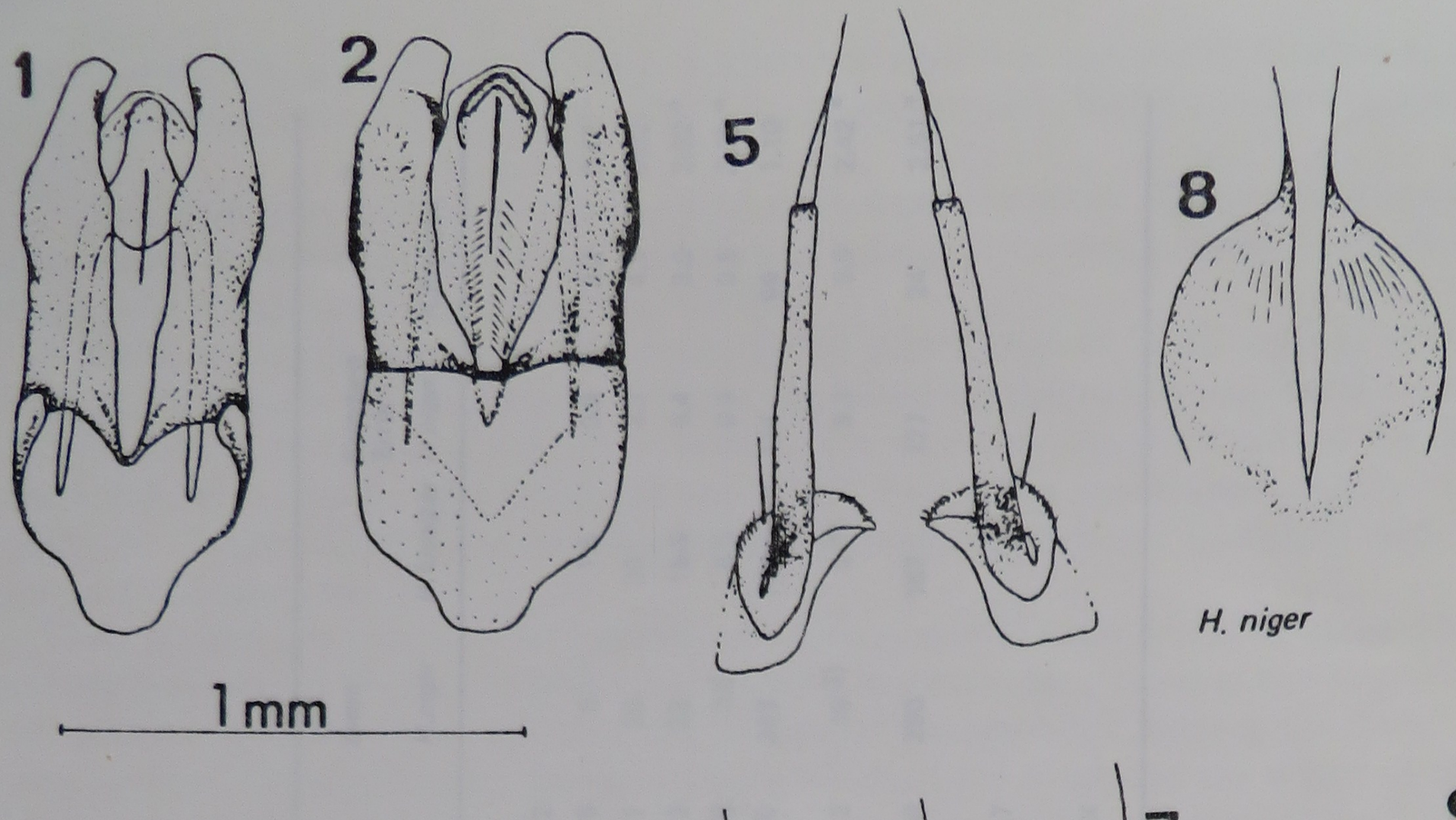

Fig. 2. *Hydrobius niger* (1 - 2, 5, 8) and *H.fuscipes* (3 - 4, 6 - 7, 9) from localities in 'Midden-Delfland'. 1 - 4: genital armature ♂♂; 1 and 3 dorsal, 2 and 4 ventral view. 5 - 7: spinnerets ♀♀; 5 and 7 dorsal, 6 ventral view. 8 - 9: grooved plates ♀♀(valvae), ventral view.

The spatial structure in terms of horizontal (B) and vertical (H, expressed in cm waterdepth) covering, was described in this Vegetation Index. In a way, a description of the density of macrophytes (biomass, HOOGERS and VAN DER WEIJ, 1970) arises from this. It could be an indication for the potential number of niches. A c-value was added, because, with different types of plants, the number of niches is not the same. The c-value indicates the number of species of Coleoptera, Heteroptera and Mollusca per type of plant. For the time being it is based on data from KRECKER (1939), KRULL (1970) and KOŘÍNKOVÁ (1971), but it will have to be adapted for our country. The numbers of species of macroinvertebrates (Coleoptera, Heteroptera and Mollusca) per type of macrophyte that were found by these authors, have been brought back to a ratio, the c-value.

The potential number of niches per type of plant might as well be described by the ratio of the plant surface to the biomass. However, the entire subject will be discussed more extensively in another paper.

Table 3. Values of some variables at locaties of *Hydrobius niger* and *H. fuscipes*.

	Hydrobius niger					*Hydrobius fuscipes*								mean		Standard Error		T
														H.niger	*H.fuscipes*	*H.niger*	*H.fuscipes*	
number of																		
- specimens	2	2	1	1	1	2	1	2	1	2	1	2	2					
- Coleoptera species	9	7	8	7	9	9	5	6	7	9	7	12	5	8	7.5	0.9	2.2	0.47
- macroinvertebrate species [1]	22	18	25	20	14	22	17	18	18	24	13	23	11	20	20	3.7	4.1	0.02
- macrophyte species	19	21	32	22	16	19	14	16	20	18	13	12	12	22	15.5	5.4	3.0	2.82 *
diversity number [2]	7	8	8	8	7	7	6	7	7	7	6	6	6	7.6	6.5	0.5	0.5	3.79 *
Vegetation Index	215	128	504	205	162	241	58	88	87	289	272	282	70	243	174	134	99	1.10
width of ditch																		
width of border vegetation	28	24	13	4	26	2	20	7	7	16	9	9	2	19 [3]	9 [4]	9.1	5.9	2.42 *
salinity ($mg.l^{-1}$)	490	156	362	188	202	178	185	128	124	167	188	174	188	280	167	127	24	2.51 *
(1980) date	3	3	21	14	15	3	8	16	25	4	15	20	17					
month		VII		VIII			VII			VIII			IX					

1) i.e. the sum of species of water snails, water bugs and water beetles.
2) According to DE LANGE and VAN ZON (1978).
3) The mean width of the ditch is 130 ± 6.3 cm and the mean width of the border vegetation is 28 ± 9.7 cm.
4) The mean width of the ditch is 144 ± 23 cm and the mean width of the border vegetation is 28 ± 23 cm.
* T-value exceeds $T_{11;0.05} = 2.20$. In that case mean values differ significantly.

RESULTS

Out of the 50 localities investigated, *H.niger* was caught at five and *H.fuscipes* at eight localities. Although these numbers are rather low, all correlations found are statistically significant.

Table 2 gives some results of the chemical analysis of the water. The mean values of the most chemical, abiotic and vegetational parameters did not differ significantly at localities of *H.niger* and *H.fuscipes* (T-test; SACHS, 1978).

A multiple regression analysis (Nie *et al.*, 1975) shows, that 42 % (R-square) of the variation of the number of Coleoptera species is explained (in decreasing sequence) by K^+ and SO_4^{2-} concentration, the 'Vegetation Index', the ratio between the width of the ditch and the width of the border vegetation and the $NO_2^- + NO_3^-$ concentration ($0.025 > P > 0.01$; $R = 0.65$; $SE = 0.20$). Only these five parameters correlate significantly (simple r) with the number of Coleoptera species.

These parameters may also have caused the presence of *H.niger* and *H.fuscipes*. Mean values have been tested (T-test) to prove differences (in parameter values) at the localities of the two species. Only the mean values of the number of macrophytic species, the floral diversity number, the salinity and the ratio of the width of the ditch and the width of the border vegetation differ significantly (Table 3). This is indicative for a species richer flora, a higher salinity (almost oligohaline; mean value of 280 $mg.l^{-1}$ Cl^-) and a less wide border vegetation at localities of *H.niger*. At localities of *H.niger* the ditch is 19 times wider than the border vegetation, while at localities of *H.fuscipes* this is 9 times.

The three-dimensional structure of the vegetation is illustrated in Fig. 3. Differences in the share of structural groups (Fig. 3) could not be established for the two species, although some groups clearly dominate. These are structural group 2 (emergent macrophytes), group 6 (linearly leaved *Potamogeton* spec. and *Zannichellia* spec.) and group 8 (*Ceratophyllum demersum*).

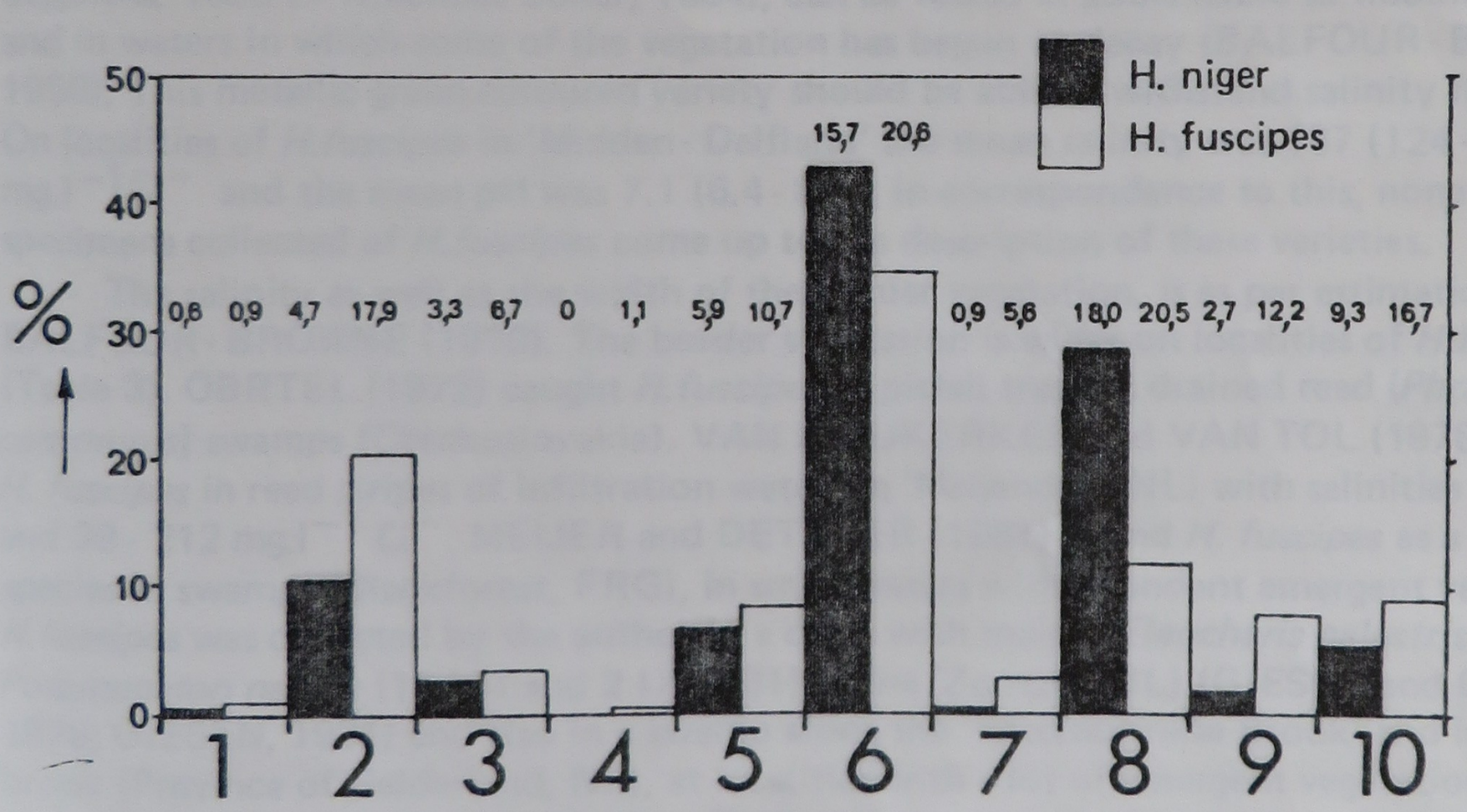

Fig. 3. The mean share (in %) of the structural groups (1 - 10, see Table 1) to the 'Vegetation Index' for *Hydrobius niger* and *H.fuscipes*. The smaller figures above the columns are the standard error.

With the exception of the width of the border vegetation in relation to the width of the ditch, mean values of none of the five parameters, which are significant in the above mentioned multiple regression analysis, differ significantly at localities of *H.niger* and *H.fuscipes*. This comes up to the expectations, because of the same mean number of Coleoptera species at localities of the two species.

The beetles are equally frequently accompanied by *Haliplus ruficollis*, *Noterus crassicornus* (which is more abundant on localities of *H.fuscipes*), *N.clavicornis*, *Hygrotus inaequalis*, *Anacaena limbata* and *Laccobius minutus*. *Graptodytes pictus* and *Helochares lividus* are more frequently collected with *H.niger*. Water bugs, equally frequently collected with both beetles are: *Ilyocoris cimicoides*, *Hesperocorixa linnei* and *Sigara striata*. *Sphaerium corneum* (Mollusca) has only been found five times together with *H.fuscipes* and just once with *H.niger*.

DISCUSSION

According to BALFOUR-BROWNE (1958, 1962) *H.niger* is a typical brackish water species in Britain. However, *H.niger* can be found indifferently in both, brackish and fresh water on the continent. LOHSE (1974) mentioned the presence of *H.niger* on the Isle of Fehmarn (Schleswig-Holstein, FRG; 20 VIII 1973). VAN DER VELDE (1967) collected *H.niger* and *H.fuscipes* in ditches along the 'Tanthofkade' (Midden-Delfland, NL). MIKŠIĆ (1977) caught *H.niger* in a small, polluted freshwater ditch, just behind the beach of the coastal region of Crna Gora. (Yugoslavia). Water beetles were abundant in this ditch. This agrees with the observed salinities during the investigation in 'Midden-Delfland' (mean value 280 (156-490) $mg.l^{-1}$ Cl^-).

H.fuscipes can be found in almost every stagnant water with a lot of aquatic vegetation. The favourite habitat appears to be a ditch or pond in which an abundance of grass is growing, or floating out on the water (BALFOUR-BROWNE, 1910). Of this species a number of varieties occurs. *H.fuscipes* var. *subrotundatus* Stephens, 1829 (= *H.picicrus* Thomson, 1883; BALFOUR-BROWNE, 1958) should be more frequent in peaty waters (acid) and is darker coloured and smaller than *H.fuscipes*. Another variety, *viz. H.fuscipes* var. *chalconotus* Stephens, 1829 (= *H.oeneus* Solier, 1834), can be found in pools liable to flooding by tides and in waters in which some of the vegetation has begun to decay (BALFOUR-BROWNE, 1958). This metallic green coloured variety should be able to withstand salinity fluctuations. On localities of *H.fuscipes* in 'Midden-Delfland' the mean salinity was 167 (124-188) $mg.l^{-1}Cl^-$ and the mean pH was 7.1 (6.4-8.3). In correspondence to this, none of the specimens collected of *H.fuscipes* come up to the description of these varieties.

The salinity as well as the width of the border vegetation, is as per estimation of BALFOUR-BROWNE (1910). The border vegetation is wider on localities of *H.fuscipes* (Table 3). OBRTEL (1972) caught *H.fuscipes* in pitfall traps in drained reed (*Phragmites communis*) swamps (Czechoslovakia). VAN NIEUKERKEN and VAN TOL (1978) collected *H. fuscipes* in reed stripes of infiltration waters in 'Meijendel' (NL) with salinities of 23 - 74 and 98 - 212 $mg.l^{-1}$ Cl^-. MEIJER and DETTNER (1981) found *H. fuscipes* as a dominant species in swamps (Blackforest, FRG), in small waters with abundant emergent vegetation. *H.fuscipes* was collected by the author in a ditch with mainly *Eleocharis palustris* and *Potamogeton natans* (18 VII and 2 IX 1981) in the 'Zompe' (NL) (GIESEN and GEURTS, 1979; GIESEN, 1981) and also in a swamp along the 'Wittenbrinkse Brook' and in this brook (Province of Gelderland, NL), at localities with a lot of emergent vegetation.

At thirteen localities in 'Midden-Delfland', the two species were not found simultaneously, neither were they in the cited references. It is possible that the two species are allopatric which means they are not concurrent.

According to JACKSON (1956), BALFOUR-BROWNE (1958) and DETTNER (1976) *H.niger* and *H.fuscipes* have a high migration rate. This may be an indication that both species react to fluctuations of the salinity by migration. Therefore the expected distribution of both species in 'Midden-Delfland' can probably be given only if these fluctuations are taken into account.

The actual distribution in 'Midden-Delfland' according to this investigation has been given in Fig. 4.

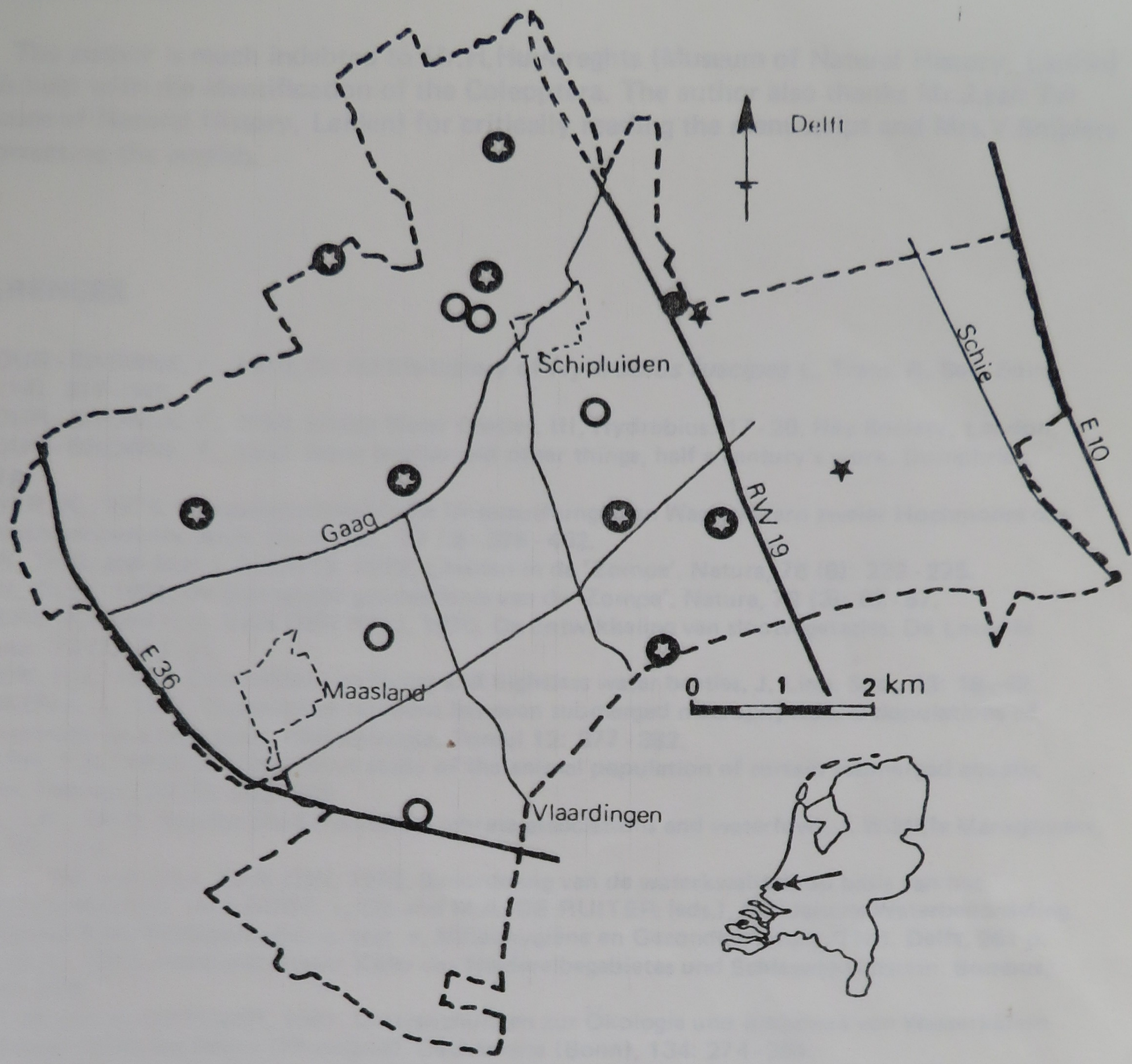

Fig. 4. Distribution of *Hydrobius niger* (circles) and *H.fuscipes* (stars) in 'Midden - Delfland' according to this investigation (open) and an earlier one (filled); broken line limits the investigated area.

SUMMARY

During a hydrobiological investigation in the polder area 'Midden-Delfland' (Province of Zuid-Holland), ecological parameters of the habitat of *Hydrobius niger* (Zschach, 1788) and *Hydrobius fuscipes* (Linnaeus, 1758) were gathered at localities of similar morphogenesis. Out of 50 localities, *H.niger* was found at 5 and *H.fuscipes* at 8 localities.

Morphological differences between the two species were summarized and illustrated (Figs. 1 and 2).

By comparing the ecological parameters of the localities of *H.niger* and *H.fuscipes*, it has been found that the salinity of the water (280 and 167 mg.l^{-1} Cl^{-} respectively), the number of species of macrophytes (22 and 16 species, respectively) and the percentage covering of emergent macrophytes (5 % and 10 %, respectively) differ significantly. Earlier obtained characteristics of the habitat of the two species seem to correspond to these results.

The two species were not found simultaneously, nor were they reported as such in the cited references.

The author is much indebted to Mr.H.Huybreghts (Museum of Natural History, Leiden) for his help with the identification of the Coleoptera. The author also thanks Mr.J.van Tol (Museum of Natural History, Leiden) for critically reading the manuscript and Mrs.V.Snijders for correcting the english.

REFERENCES

BALFOUR - BROWNE, F., 1910. On the life-history of *Hydrobius fuscipes* L. Trans. R. Soc. Edin., 47 (14): 317 - 340.

BALFOUR - BROWNE, F., 1958. British Water Beetles. III, Hydrobius: 17 - 20. Ray Society, London.

BALFOUR - BROWNE, F., 1962. Water beetles and other things, half a century's work. Dumphries, 210 p.

DETTNER, K., 1976. Populationsdynamische Untersuchungen an Wasserkäfern zweier Hochmoore des Nordschwarzwaldes. Arch. Hydrobiol., 77 (3): 375 - 402.

GIESEN, Th.G. and M.H.J. GEURTS, 1979. Libellen in de 'Zompe'. Natura, 76 (8): 222 - 225.

GIESEN, Th.G., 1981. De geologische geschiedenis van de 'Zompe'. Natura, 78 (3): 62 - 67.

HOOGERS, B.J. and H.G. VAN DER WEIJ, 1970. De ontwikkeling van slootvegetaties. De Levende Natuur, 73 (1): 13 - 21.

JACKSON, D.J., 1956. Observations on flying and flightless water beetles. J. Linn. Soc., 43: 18 - 42.

KOŘÍNKOVÁ, J., 1971. Quantitative relations between submerged macrophytes and populations of invertebrates in a carp pond. Hidrobiologia, Tomul 12: 377 - 382.

KRECKER, F.H., 1939. A comparative study of the animal population of certain submerged aquatic plants. Ecology, 20 (4): 553 - 562.

KRULL, J.N., 1970. Aquatic plant-macroinvertebrate associations and waterfowl. J. Wildlife Management, 34: 707 - 718.

LANGE, L. DE and J.C.J. VAN ZON, 1978. Beoordeling van de waterkwaliteit op basis van het macrofytenbestand. In: LANGE, L. DE and M.A. DE RUITER (eds.), Biologische Waterbeoordeling. Werkgroep Biol. Waterbeoordeling. Inst. v. Milieuhygiëne en Gezondheidszorg, TNO. Delft, 251 p.

LOHSE, G.A., 1974. Neue und seltene Käfer des Niederelbegebietes und Schleswig-Holstein. Bombus, 2 (54): 216.

MEIJER, W. and K. DETTNER, 1981. Untersuchungen zur Ökologie und Bionomie von Wasserkäfern der Drover Heide bei Düren (Rheinland). Decheniana (Bonn), 134: 274 - 291.

MIKŠIĆ, R., 1977. Neue Beiträge zur Kenntnis des Bestandes der Coleopteren-Fauna des Küstenlandes der Crna Gora. Glas. Republ. Zavoda Zast. Priroda i Prirodnjackog Muzeja Titograd, 10: 37 - 40.

NIE, N.H., C.H. HULL, J.G. JENKINS, K. STEINBRENNER and D.H. BENT, 1975. Statistical Package for Social Sciences. New York, 675 p.

NIEUKERKEN, E.J. VAN and J. VAN TOL, 1978. Lijst van waterkevers van Meijendel (Coleoptera). Fauna van de wateren van Meijendel III. Zoöl. Bijdr., Leiden (Bijdr. Faun. Nederland V), 23: 92 - 125.

OBRTEL, R., 1972. Soil surface Coleoptera in a reed swamp. Acta Sc. Nat. Brno, 6 (9): 1 - 35.

SACHS, L., 1978. Angewandte Statistik. Methoden und ihre Anwendung. Berlin, 552 p.

VELDE, G. VAN DER, 1967. Floristische en hydrobiologische inventarisatie 1962 - 1967. Sloten langs de Tanthofkade bij Den Hoorn. Inventarisatieverslag NJN - Delft. Rijswijk, 9 p.

Address of the author:
Van Roggestraat 8, 7011 GE Gaanderen, The Netherlands.