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ASSESSMENT OF ABUNDANCE AND DISTRIBUTION OF THE ROMAN SNAIL (*HELIX POMATIA* LINNAEUS, 1758) IN KUJAWSKO-POMORSKIE VOIVODESHIP

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ABSTRACT: Populations of *Helix pomatia* L. in Poland have been commercially exploited since 1951; the snails are mostly exported. The growing interest in the Roman snail on the European market has resulted in its increased exploitation, in some areas leading to a considerable decrease in its abundance. Introducing export quota in 1964 did not prevent overexploitation. Precise assessment of abundance and distribution of the Roman snail populations in areas where it is exploited is necessary. In 2009 the team from the Faculty of Biology, Adam Mickiewicz University in Poznań, conducted a preliminary assessment and mapping of the abundance and distribution of the Roman snail populations in Kujawsko-Pomorskie voivodeship. Most populations showed a low density. From scientific point of view the most reasonable solution would be to suspend exploitation in 2010 and continue monitoring, while decisions to issue permits for limited exploitation should be postponed till 2011. It would enable a more detailed estimation of the non-exploited populations and an assessment of losses resulting from exploitation of controlled reference populations. In this way acceptable limits of annual commercial collecting could be set for particular parts of the voivodeship.

KEY WORDS: *Helix pomatia*, population resources, exploitation quota, species protection, exploitation limits, purchase centres

INTRODUCTION

The Roman snail (*Helix pomatia* Linnaeus, 1758), the largest terrestrial snail in the country, is the only commercially exploited mollusc in Poland. Its exploitation started after World War II, in 1951. It was initiated by the Forest Production Cooperative "LAS", and initially included the Poznań, Bydgoszcz and Wrocław voivodeships (URBAŃSKI 1963, STĘPCZAK 1976). The growing interest in the Roman snail on the European market caused its increased exploitation and expansion of the exploited areas (STĘPCZAK 1976). In 1961–1974 the annual export to France and partly Germany was ca. 300 tons of snails (STĘPCZAK 1976). Only live specimens were exported, and no attempts at processing were made in the country.

The exploitation was the greatest in Lower Silesia (ca. 31% of the country's yield), in the region of Szczecin (ca. 15%), in Wielkopolska (9.6%) and the environs of Zielona Góra (8.3%). The yield from the area corresponding to the present-day Kujawsko-Pomorskie voivodeship was nearly 3%, which made it the tenth snail harvest region in the country (STĘPCZAK 1976). Already in 1960–1963 the increasing intensity of the

Roman snail exploitation in Poland caused a decline or even disappearance of the species in some areas (BIULETYN CIS 1962, URBAŃSKI 1963). In response to this situation the Central Inspectorate for Standardisation issued new export standards, the acceptable size being shell diameter exceeding 30 mm (till 1963 snails above 28 mm were purchased). At the same time the collecting season was limited to May. The standards were introduced in 1964, and are still in force.

Considerable changes in the management of the Roman snail resources took place in the 1980s and after 1990. Development of processing in Poland and cessation of export of live snails, suggested much earlier (STĘPCZAK 1976), had a favourable effect. The other changes were and still are negative. Numerous firms were established, dealing exclusively with Roman snail exploitation and processing, and seeking fast profit. As a result the Roman snail exploitation in many regions became very intensive. This was favoured by frequent unemployment periods when many people started collecting the snails in order to obtain even a very small income. The number of people owning cars also increased, and the snails could be delivered to the purchase centres from increasingly greater distances and in larger quantities.

In view of these facts it became necessary to assess the abundance and distribution of the Roman snail populations in the areas where it was exploited. The results should make it possible to determine the acceptable exploitation quota of this partially protected species, at the level not dangerous to the natural populations.

On the commission of the Regional Administration of Environment Protection in Bydgoszcz the team from the Department of General Zoology, Natural History Collections and Laboratory for Nature and Biology Education, Faculty of Biology, Adam Mickiewicz University in Poznań, conducted a preliminary assessment of abundance and distribution of the Roman snail populations in Kujawsko-Pomorskie voivodeship. The results provide a starting point for constant monitoring of abundance and distribution of the species in particular communes of the voivodeship planned for 2010–2015.

MATERIAL AND METHODS

The studies included all the communes in Kujawsko-Pomorskie voivodeship. Field work was conducted from May 3rd till July 2nd 2009. At least three sites of potential occurrence of the Roman snail were selected in each commune, based on satellite maps, and then verified in the field. Additionally, other potential sites were checked during field work. In each site all observed individuals were collected from an area of 1–2 ares during 10 minutes. It was assumed that a team of 3–4 people could collect up to 35% of all snails present in the examined plot. Usually, a single collector can collect 15–20% of individuals in the area (STĘPCZAK 1976). The individuals were counted, weighed, their size was noted (within standard versus below standard ratio) and divided into mature (growth terminated) and juvenile, based on the presence/absence of lip. The snails were then released in the collection site. The resulting estimated relative densities served as the basis for distribution and abundance maps. Five categories of communes were distinguished based on the number of snails per 1 are plot:

1. Communes with Roman snail resources of commercial size: >30 individuals,
2. Communes with abundant Roman snail populations: 30–11 individuals,
3. Communes with moderately rich Roman snail populations: 4–10 individuals,
4. Communes with poor Roman snail populations,
5. Communes where no Roman snail was found.

Data from the Regional Administration of Environment Protection in Bydgoszcz on the distribution of Roman snail purchase centres 2001–2008 served as the basis for maps (Figs 2–6) of the purchase centre distribution.

RESULTS

SPATIAL STRUCTURE OF THE ROMAN SNAIL DISTRIBUTION IN KUJAWSKO-POMORSKIE VOIVODESHIP

Out of more than 280 plots verified in the field, only 53 yielded 30 and more individuals of the Roman snail. In the remaining plots single individuals were observed; few plots yielded from several to about a dozen snails. No *H. pomatia* was found in 105 of the all examined plots. Fig. 1 presents the five categories of density in individual communes. Three distinct groups of communes with rich Roman snail resources (more than 30 individuals/1 are) could be distingished in Kujawsko-Pomorskie voivodeship in the studied period.

The first and largest group includes the communes of the south-western part of the voivodeship (arrangement of communes alphabetical): Barcin, Dąbrowa, Dąbrowa Biskupia, Dobre, Inowrocław, Janikowo, Janowiec Wielkopolski, Kcynia, Kruszwica,

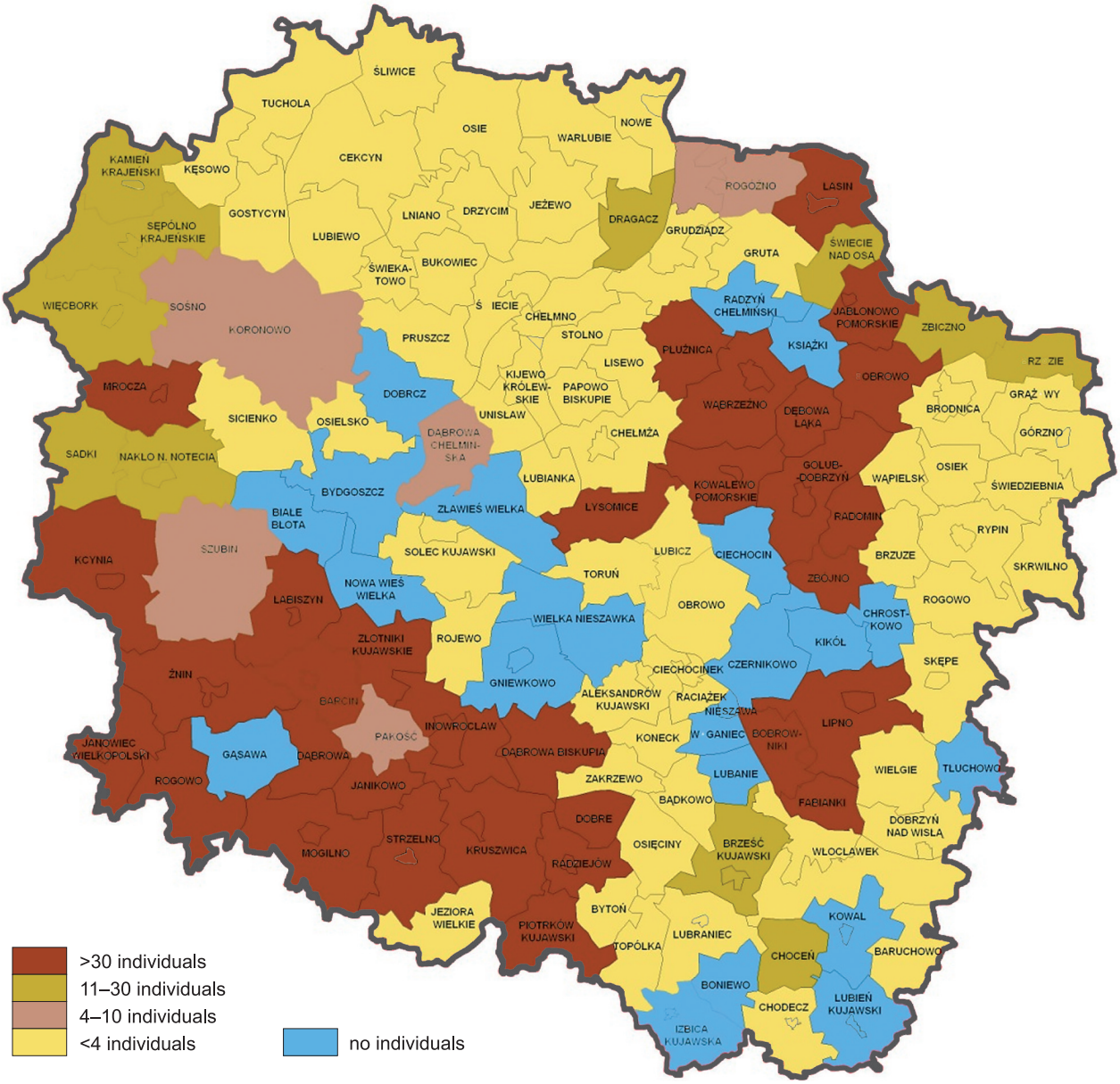

Fig. 1. Structure of Roman snail distribution in the communes of Kujawsko-Pomorskie voivodeship in May–June 2009

Łabiszyn, Mogilno, Piotrków Kujawski, Radziejów, Rogowo, Strzelno, Złotniki Kujawskie, Żnin. The second group includes communes located in the north-eastern part of the area: Bobrowo, Dębowa Łąka, Golub-Dobrzyń, Jabłonowo Pomorskie, Kowalewo Pomorskie, Łasin, Łysomice, Płużnica, Radomin, Wąbrzeźno, Zbójno. The third and smallest group includes three communes in the eastern part of the voivodeship: Bobrowniki, Fabianki and Lipno.

Besides, considerable Roman snail resources were found in communes Dąbrowa Chełmińska, Koronowo, Pakość, Rogoźno, Sośno, Szubin, with populations of a density from 4 to 13 individuals/1 are. Only single individuals of the Roman snail were found in the remaining communes during the inventory.

LOCATION OF PURCHASE CENTRES AND SPATIAL DISTRIBUTION OF ROMAN SNAIL RESOURCES

The information on the purchase centre distribution in Kujawsko-Pomorskie voivodeship in 2001–2008, obtained from the Regional Administration of Environment Protection in Bydgoszcz, served to select the communes with Roman snail populations which were abundant enough to make commercial collecting profitable.

Figs 2–6 present the distribution of communes which in 2001–2008 held purchase centres. It largely corresponds to the abundant resources of the Roman snail in individual communes (cf. Fig. 1). Data of 2001 are imprecise (no location of purchase centres

Table 1. Numer of Roman snail purchase centres in the communes of Kujawsko-Pomorskie voivodeship in 2001–2008 and size of purchase in each year (data from Regional Administration of Environment Protection in Bydgoszcz): ? – data uncertain or no data

No.	Commune	2001	2002	2003	2004	2005	2006	2007	2008	Numer of purchase centres
1	Gostycyn	1	1	1	1	2	1	1	2	10
2	Mrocza		1	1	1	1	1	2	2	9
3	Mogilno		1	1	1	1	1	1	1	7
4	Pakość		1	1		2	2	2	1	9
5	Barcin		1	1		2	2	1	1	8
6	Strzelno		1	1		1	1	1	1	6
7	Nakło nad Notecią				2	4	2	1	3	12
8	Kcynia				1	2	2	1	1	7
9	Złotniki Kujawskie					2	2	1		5
10	Sadki					2	2	2	3	9
11	Toruń					2	2	3	2	9
12	Świecie				1	3	1	3		8
13	Zbiczno					2	2	2	2	8
14	Brodnica					3	2	3		8
15	Brzozie					1	2	3	2	8
16	Kruszwica					2	2	2	2	8
17	Kamień Krajeński					3	1	1	2	7
18	Golub-Dobrzyń					2	2	2	1	7
19	Gniewkowo				1	3	1	2		7
20	Inowrocław					2	2	2	1	7
21	Osiek					2	2	1	1	6
22	Żnin					2	2	1	1	6
23	Czernikowo				1	2	1	2		6
24	Kikół				1	2	1	2		6
25	Cekcyn					1	1	2	1	5
26	Górzno					1	2	1	1	5
27	Bobrowniki				1	2	1	1		5
28	Wąbrzeźno					1	1	1	1	4
29	Tuchola				1	2		1		4
30	Jeżewo					2	1	1		4
31	Więcbork					2	1	1		4
32	Osie					1	1	1		3
33	Warlubie					1	1	1		3
34	Nowe					1	1	1		3
35	Drzycim					1	1	1		3
36	Grudziądz					1	1	1		3
37	Rogoźno					1	1	1		3
38	Łasin					1	1	1		3
39	Gruta					1	1	1		3
40	Świecie nad Osą					1	1	1		3
41	Chełmno					1	1	1		3
42	Stolno					1	1	1		3

No.	Commune	2001	2002	2003	2004	2005	2006	2007	2008	Numer of purchase centres
43	Radzyń Chełmiński (Radzymin)					1	1	1		3
44	Jabłonowo Pomorskie					1	1	1		3
45	Unisław					1	1	1		3
46	Papowo Biskupie					1	1	1		3
47	Lisewo					1	1	1		3
48	Szubin					1	1	1		3
49	Łabiszyn					1	1	1		3
50	Solec Kujawski					1	1	1		3
51	Janowiec Wielkopolski					1	1	1		3
52	Rogowo					1	1	1		3
53	Gąsawa					1	1	1		3
54	Janikowo					1	1	1		3
55	Lubraniec					1	1	1		3
56	Brześć Kujawski					1	1	1		3
57	Włocławek					1	1	1		3
58	Dobrzyń nad Wisłą					1	1	1		3
59	Izbica Kujawska					1	1	1		3
60	Choceń					1	1	1		3
61	Kowal					1	1	1		3
62	Chodecz					1	1	1		3
63	Koronowo					1			2	3
64	Chełmża					1	1			2
65	Lipno				1			1		2
66	Fabianki					1	1			2
67	Piotrków Kujawski		1	1						2
68	Jeziora Wielkie					1	1			2
69	Dąbrowa					1	1			2
70	Kowalewo Pomorskie					2				2
71	Sępólno Krajeńskie					1				1
72	Lubiewo							1		1
73	Świekatowo							1		1
74	Bukowiec							1		1
75	Sośno					1				1
76	Pruszcz							1		1
77	Bobrowo					1				1
78	Brzuze					1				1
79	Rypin					1				1
80	Raciążek							1		1
81	Skępe							1		1
82	Lubanie						1			1
83	Topólka		1							1
	Total	1	8	7	13	104	82	88	34	337
	Yield [kg]	34,618.6	24,041.5	20,358	15,236	29,000?	19,000	??	19,850	

Fig. 2. Communes with Roman snail purchase centres (darker) in 2001–2004

Fig. 5. Communes with Roman snail purchase centres (darker) in 2007

Fig. 3. Communes with Roman snail purchase centres (darker) in 2005

Fig. 6. Communes with Roman snail purchase centres (darker) in 2008

Fig. 4. Communes with Roman snail purchase centres (darker) in 2006

given). In subsequent years, till 2004, such centres were located only in a few communes. More purchase centres appeared in Kujawsko-Pomorskie voivodeship since 2005 (Fig. 3). They concentrated mainly on the margins of the voivodeship. The central part, which according to the inventory has no commercially valuable Roman snail populations, is also devoid of purchase centres.

Table 1 shows a list of purchase centres in individual communes in 2001–2008. Such centres functioned in 83 communes (58% of all communes of the voivodeship). Their number in individual communes in a year varied from one to four. Only in one commune – Gostycyn – purchase centres were opened every year starting with 2001. Likewise, in communes Mrocza and Mogilno, purchase centres operated since 2002. The maximum number of purchase centres (12) in 2001–2008 was noted in communes Nakło on the Noteć (2004–2008) and Gosty-

Table 2. Characteristics of selected Roman snail populations: N – number of specimens; J:A – juvenile/adult ratio [%]; DM:DD – size structure of adults [in %], (DM – individuals below standard size, DD – individual of standard size); Bio^{tot} – biomass of collected individuals [g], Bio^{ind} – mean individual biomass (mean±SD) [g]; n/kg – number of individuals required to obtain 1 kg of snails; ind./are – density per 100 m^2

Locality	Commune	N	J:A	DM:DD	Bio^{tot}	Bio^{ind}	n/kg	ind./ 100 m^2
Barcin – UTM: YU00 11	Barcin	32	26:74	9:91	679	24.4 ±4.5	41	27.1
Piechcin – UTM: YU00 11	Barcin	167	28:72	–	–	–	–	11.0
Pturek – UTM: YU00 11	Barcin	53	53:47	–	–	–	–	6.2
Małki I – UTM: CE80 30	Bobrowo	97	69:31	–	–	–	–	26.3
Małki II – UTM: CE80 30	Bobrowo	97	34:66	10:90	1,950	22.7 ±3.4	44	28.9
Laski Wielkie – UTM: XU93 01	Dąbrowa	87	71:29	4:96	1,332	18.4 ±2.1	54	22.0
Mierucin – UTM: YU04 18	Dąbrowa	82	48:52	53:47	1,266	24.2 ±3.4	41	30.0
Ośniszczewko – UTM: CD31 31	Dąbrowa Biskupia	84	49:51	7:93	1,542	21.4 ±3.2	47	38.0
Ostromecko – UTM: CD19 32	Dąbrowa Chełmińska	57	23:77	9:91	1,171	23.7 ±4.6	42	31.0
Dębowa Łąka – UTM: CE70 22	Dębowa Łąka	74	18:82	1:99	1,733	21.8 ±3.5	45	7.0
Niedźwiedź – UTM: CE60 82	Dębowa Łąka	114	33:67	4:96	2,338	23.1 ±2.6	43	8.5
Gałczewko – UTM: CD79 02	Golub–Dobrzyń	105	71:29	–	–	–	–	26.0
Gałczewko II – UTM: CD79 02	Golub–Dobrzyń	104	71:29	8:92	1,844	21.8 ±2.7	46	8.1
Inowrocław – UTM: CD13 28	Inowrocław	53	51:49	–	–	–	–	6.0
Jabłonowo Pomorskie – UTM: CE71 57	Jabłonowo Pomorskie	77	61:39	–	–	–	–	26.3
Jabłonowo Pomorskie II – UTM: CE71 57	Jabłonowo Pomorskie	78	38:62	10:90	1,401	19.8 ±2.0	50	26.3
Janikowo – UTM: CD04 36	Janikowo	75	67:33	16:84	1,289	20.5 ±2.3	49	21.9
Kołdrąb – UTM: XU44 35	Janowiec Wielkopolski	118	36:64	16:84	2,261	21.7 ±2.9	46	29.4
Łopienno – UTM: XU64 73	Janowiec Wielkopolski	60	38:62	35:65	1,151	21.8 ±2.9	46	32.4
Żurawia – UTM: XU67 74	Kcynia	40	67:33	15:85	651	21.1 ±3.6	47	35.0
Wtelno – UTM: XV93 50	Koronowo	52	17:83	16:84	1,051	21.2 ±2.6	47	37.6
Frydrychowo – UTM: CD69 12	Kowalewo Pomorskie	148	36:64	3:97	3,275	25.4 ±2.7	46	26.3
Kobylniki – CD 14 70	Kruszwica	162	49:51	–	–	–	–	18.9
Kruszwica – UTM: CD10 18	Kruszwica	159	30:70					18.6
Piaski – UTM: CD24 50	Kruszwica	58	22:78	4:96	1,315	25 ±3.7	40	39.4
Rożniaty – UTM: CD24 50	Kruszwica	81	23:77	–	–	–	–	9.5
Jankowo – UTM: CD02 67	Pakość	68	34:66	18:82	1,210	19.9 ±3.2	50	39.4
Lipno – UTM: CD77 40	Lipno	48	52:48	17:83	712	19 ±3.7	53	16.1
Jankowice – UTM: CD14 83	Łasin	97	33:67	5:95	2,044	23.6 ±3.5	42	56.9
Łabiszyn – XU97 70	Łabiszyn	174	19:81	–	–	–	–	16.5
Załachowo – UTM: XU94 07	Łabiszyn	100	12:88	–	–	–	–	11.7
Mogilno I – UTM: YU03 26	Mogilno	148	80:20	0:100	1,218	21.4 ±3.4	47	61.6
Mogilno II – UTM: YU03 26	Mogilno	66	77:23	–	–	–	–	7.7
Mrocza – UTM: XV70 43	Mrocza	104	41:59	7:93	2,023	23.6 ±3.7	42	53.4
Rybitwy – UTM: CD05 02	Pakość	39	21:79	19:81	733	19.9 ±2.7	50	34.1
Piotrków Kujawski – UTM: CD 30 40	Piotrków Kujawski	77	25:75	–	–	–	–	9.0
Płużnica – UTM: CE50 27	Płużnica	72	49:51	3:97	1,322	21.6 ±2.7	–	6.4
Szafarnia – UTM: CD78 56	Radomin	74	26:74	18:82	1,725	25.9 ±4.4	39	6.5
Wąbrzeźno – UTM: CE63 03	Wąbrzeźno	114	50:50	14:86	2,056	21.3 ±1.8	47	8.5
Wielgie – UTM: CD77 23	Zbójno	97	11:89	36:64	2,581	27.7 ±5.3	36	7.7

cyn (10). In communes Mrocza, Sadki, Toruń and Pakość nine purchase centres were opened. Twelve communes had 7–8 purchase centres each, and 13 communes – 4–6 purchase centres each. Communes with three purchase centres were the most numerous – 32. The remaining 20 communes had 1–2 purchase centres each.

CHARACTERISTICS OF SELECTED ROMAN SNAILS POPULATIONS IN KUJAWSKO-POMORSKIE VOIVODESHIP

Among the 281 examined plots in Kujawsko-Pomorskie voivodeship, 175 held Roman snail (62%). Only 53 plots (19%), with 30 individuals each, can be regarded as commercially interesting (Table 2). In 105 plots (37%) only one to ten individuals were found. In 105 plots no Roman snail was found (Fig. 7).

The Roman snail density in 40 plots selected among the richest plots in Kujawsko-Pomorskie voivodeship ranged from six to 62 individuals per 1 are (mean 23.33±14.50). Adult indviduals in these populations reached a weight ranging from 18.4 to 27.7 g (mean 22.29±2.21). In these populations on average 36 to 54 individuals (mean 45.4±4.3) were needed to harvest 1 kg of Roman snail.

The age structure in the examined populations varied. Adults dominated in 27 populations (68%),

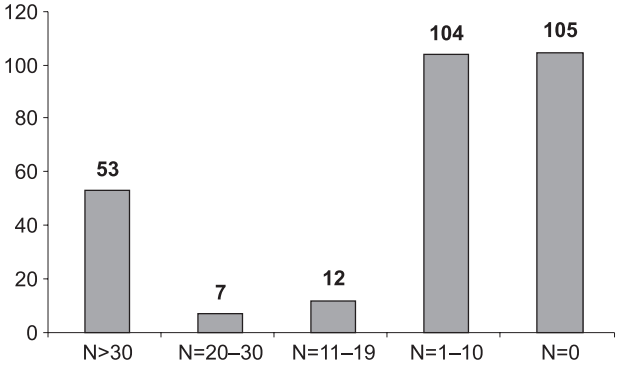

Fig. 7. Occurence of Roman snail populations in Kujawsko-Pomorskie voivodeship. N = number of individuals, Y axis – number of populations in particular abundance groups

while the proportion of juveniles varied among populations and ranged from 11 to 80%.

The proportion of snails with shell diameter exceeding 30 mm and snails below the standard size in the studied populations was also assessed. The proportion may indicate dwarfing or predominance of slender, high-spired individuals which may be a side-effect of selection during intensive exploitation. In most of the examined populations the proportion of adults below the standard size did not exceed 20%; it ranged from 0 to 53%. Only in three populations (Mierucin, Łopienno, Wielgie) a tendency to dwarfing was distinct, with small adults (<30 mm) exceeding 30%.

DISCUSSION

The greatest problem at present is the estimation of the actual abundance and biomass of Roman snail over a large area of Kujawsko-Pomorskie voivodeship. All the previously used methods were very imprecise. The first (and only) attempt at an assessment of the Roman snail resources in Poland was STĘPCZAK's (1976) study. Based on the UTM square grid (25 × 25 km) and the number of Roman snail localities in each square, the author presented the density of Roman snail records in the whole of Poland. The basic data for the map of the density of Roman snail records were derived from inquiries in schools and purchase centres, as well as from literature and collections of the Department of General Zoology, Adam Mickiewicz University. STĘPCZAK (1976) distinguished four categories of locality distribution, from no or very rare occurrence of the snail to six or more records per square. It seems that the method is biased, because of the uneven collecting effort in individual squares, ignoring the propotion of adequate Roman snail habitats in each and the absence of direct verification of the inquiry results. The data should thus be regarded as tentative. The number of records in each square does not reflect the population density or fluctuations in population abundance. However, the comparison of current observations and STĘPCZAK's (1976) results, presented by KOŁODZIEJCZYK & SKAWINA (2009) for the northern part of Mazovia, shows that they are well compatible. Their observations suggest that in the studied area the Roman snail is very rare and has shown no expansion tendency at least for 35–45 years.

The greatest problem with the estimation the Roman snail resources is the lack of studies on the precise boundaries and real abundance of its populations. The estimates based on single samples do not provide a basis even for a rough estimate of the snail's abundance and biomass. It is practically impossible to gain such information without prior ascertainment of the area occupied by the population and precise whole-season observations of marked individuals. It is not exactly known if within an area exceeding 10 ha the snail forms a large metapopulation or several isolated populations.

Collecting has a significant impact on the density of snail populations, and it affects different age classes in different ways (ANDREEV 2006). Based on studies in Moldova, ANDREEV (2006) found that the mean density of exploited Roman snail populations could drop even seven times. Literature information on the de-

gree to which collectors limit the abundance of natural populations is scarce. The absence of these two basic pieces of information makes the exploitation quota inaccurate, since they are issued each year, based only on a very rough assessment which may even lead to local extinctions of the species. It should be borne in mind that Roman snail plays an important role in terrestial ecosystems, providing food and shelter for a large number of invertebrates and vertebrates (UVALIEVA 1990). Depending on its abundance, it accelerates the litter decomposition even up to several times (STRIGANOVA 1975, 1980), and produces considerable quantities of soil-fertilising faeces. It is estimated that the snails occurring in 1 ha, with a biomass of 34 kg, are able to consume more than 650 kg plant biomass during their entire active period (TUŘCEK 1970a, b).

The main aim of the study was to assess the Roman snail resources in Kujawsko-Pomorskie voivodeship and express an opinion on their possible commercial exploitation. Is the Roman snail common in the voivodeship? Its frequency in the samples, 81%, obtained in our inventory, seems to indicate that it is common. According to our results the low density of Roman snail in most of the studied populations (usually single individuals were found) indicates that from the scientific point of view the most rational solution would be to suspend commercial exploitation in 2010 and continue monitoring, while issuing permissions for limited collecting should be postponed till 2011. This would make it possible to assess the non-exploited populations in more detail (population structure, abundance, density etc.), and then estimate the losses caused by exploitation in selected, monitored populations. This in turn would make it possible to set acceptable quota of annual commercial collecting for various parts of the voivodeship.

At the same time, considering social and economic factors, it was decided, for the communes with rich Roman snail populations (Fig. 1, communes marked with brown), to issue purchase permissions for 2010, for quantities not exceeding the quantities of Roman snail bought by the purchase centres of 2008.

If climatic conditions in the spring-summer season of 2010 proved favourable to the Roman snail (high humidity, optimum temperature, rich herb vegetation), in 2011 it would be possible to issue permissions to harvest the snail at the same quantity. However, it will be impossible to assess the Roman snail resources and possibly suspend exploitation or determine its quota in 2012, without comparative studies estimating the effect of exploitation in the previous years. It is recommended to continue monitoring for at least four years i.e. the minimum period required by this year's hatchlings to reach commercial size.

Further detailed studies are necessary, especially on the real assessment of Roman snail resources in Poland and functioning of its populations in various conditions. They will not only make possible actions to protect the species, but also to specify precise quota of commercial collecting to prevent overexploitation.

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REFERENCES

ANDREEV N. 2006. Assessment of the status of wild populations of land snail (escargot) *Helix pomatia* L. in Moldova: The effect of exploitation. Biodiversity and Conserv. 15: 2957–2970.

BIULETYN CIS (BIULETYN CENTRALNEGO INSPEKTORATU STANDARYZACJI) 1962. Ślimak winniczek. Warszawa.

KOŁODZIEJCZYK A., SKAWINA A. 2009. The Roman Snail (*Helix pomatia* Linneus, 1758) in Northern Masovia. Folia Malacol. 17: 69–72.

STĘPCZAK K. 1976. Distribution, abundance and protection of the Roman snail (*Helix pomatia*) in Poland. Wyd. Nauk. UAM, Poznań, Ser. zool. 3: 1–68.

STRIGANOVA B. P. 1975. Roly pochvoobitayushchikh bezpozvonochnykh v destruktsionnykh procesakh. Rol zhivotnykh v funktsionirovanyi ekosistem. Nauka, Moskva: 58–61.

STRIGANOVA B. R. 1980. Pitanye pochvennykh saprofagov. Nauka, Moskva.

TUŘCEK F. J. 1970a. Growth in the early juvenile Roman snail, *Helix pomatia* L. and secondary netto production. Biologia 25: 555–558.

TUŘCEK F. J. 1970b. Studies on the ecology and production of the Roman snail *Helix pomatia* L. Biologia 25: 103–108.

URBAŃSKI J. 1963. Roman snail, *Helix pomatia* L. – systematics, biology, economical significance and protection. Ochr. Przyr. 29: 215–254.

UVALIEVA C.C. 1990. Nazemnye mollyuski Kazakhstana i sopredelnykh stran. Nauka Kaz, Alma Ata.

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