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SPECIES COMPOSITION AND ABUNDANCE DYNAMICS OF SLUGS (GASTROPODA TERRESTRIA NUDA) IN URBAN CONDITIONS

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ABSTRACT: A total of 5111 slug specimens of 8 species were caught in 1994–1996 in an urban habitat in Rzeszów (SE Poland), the most abundant being *Arion rufus* (L.). Other abundant species were: *Arion fasciatus* (Nilsson, 1822) *Deroceras reticulatum* (O. F. Müll.) and *Limax maximus* L. The abundance of slugs varied between the seasons and depended on weather conditions (rainfall, temperature, air humidity); reaction to frosty winters varied between species.

KEY WORDS: slugs, anthropogenic habitats, species composition, abundance dynamics

INTRODUCTION

An abundant appearance of slugs in agricultural and horticultural crops of Rzeszów voyvodeship in 1992–1993 encouraged us to study their species composition and abundance dynamics. Previous studies in that area revealed a high incidence of slug-caused damage to cultivated plants (KOZŁOWSKI & KORNOBIS 1994, KOZŁOWSKI 1995, PISAREK & SIONEK 1996, SIONEK 1996). The slugs occur both in cultivated fields and city habitats. Uninteresting from the viewpoint of species diversity, such habitats are mostly avoided by malacologists. As a result, their slug species composition, and especially abundance dynamics, are rather poorly studied. The lack of basic data makes it impossible to propose rational means of pest slug control.

The aim of this study was to investigate species composition and abundance dynamics of slugs in urban conditions where recently populations of some species have become a serious threat to horticultural crops.

MATERIAL AND METHODS

Observations and collecting of slugs were carried out from half of May 1994 till the end of 1996, in the city of Rzeszów (SE Poland), district Staroniwa. The study plot, of ca. 0.25 ha, was located close to a stream, railroad and a busy street. It included several buildings, a garden with a variety of cultivated plants and bushes on the bank of the stream. Slugs were caught in traps, according to the method described earlier (KOZŁOWSKI et al. 1996). The bait was a molluscicide Mesurol Schneckenkorn (4% mercaptodimethur) and bran. During the whole study period, the traps were emptied twice a week, and the slugs were identified based on RIEDEL & WIKTOR (1974) and WIKTOR (1989, 1996). In the spring, additionally possible shelters of slugs were examined in order to determine the period of slug appearance. Weather conditions were followed based on the data from the weather station in Jasionka near Rzeszów.

RESULTS AND DISCUSSION

Eight slug species were found in 1994–96 in the studied urban habitat (Rzeszów – Staroniwa): *Arion fasciatus* (Nilsson, 1822), *A. distinctus* (Mabille, 1868), *A. rufus* (Linnaeus, 1758), *A. subfuscus* (Draparnaud, 1805), *Deroceras laeve* (O.F. Müller, 1774), *D. sturanyi* (Simroth, 1894), *D. reticulatum* (O.F. Müller, 1774) and *Limax maximus* Linnaeus, 1758. The dominant was *A. rufus*. The number of specimens of this species collected within three years was 40.3% of all collected slugs. Of the remaining species the most abundant was *A. fasciatus* (20.2%), less so *D. reticulatum* (16.7%) and *L. maximus* (16.6%). *A. distinctus* constituted 4.4%, while the proportion of *D. sturanyi*, *D. laeve* and *A. subfuscus* ranged from 0.5 to 0.7% all collected slugs (Table 1). The frequency during the three years was the highest in the case of *L. maximus* (70.2%) and *A. rufus* (67.2%). *A. fasciatus* (58.0%) and *D. reticulatum* (56.9%) were also fairly frequent (Table 2).

The abundance and frequency of particular slug species varied considerably between the observation dates. In 1994 (Fig. 1), slugs were the most abundant in the third decade of May and the first decade of June. In this period the total number of rainy days was 13, the mean diurnal air temperature being 13.4°C to 14.8°C. At the end of July, as a result of the lack of rain (6 rainy days in July) the slug abundance decreased. The low abundance persisted in August, and increased slightly in the first half of September as a result of increased rainfall. The slugs were collected continuously almost till the end of November and single individuals were caught till the end of December. Plus temperatures at the end of 1994 resulted in a quick development of eggs and hatching of juvenile *D. reticulatum* and *A. rufus* which favourably affected their population abundance in the following year. In 1995 (Fig. 2), first slugs were caught at the end of the second decade of February. The number of caught specimens increased steadily with increasing temperature. The highest number of slugs was noted from the second decade of June till the first decade of July. In that period the number of rainy days was 12. In July and August the number of slugs decreased which was

Table 1. Species composition and species abundance of slugs in Rzeszów-Staroniwa in 1994–1996

Species	1994		1995		1996		Total	1994-1996
	Number	%	Number	%	Number	%	Number	%
A. rufus	869	55.30	1096	39.80	97	12.40	2062	40.34
L. maximus	231	14.70	395	14.00	221	28.20	847	16.57
A. fasciatus	383	24.40	412	14.90	238	30.40	1033	20.21
D. reticulatum	77	4.90	695	25.30	83	10.60	855	16.73
A.distinctus	11	0.70	102	3.70	114	14.50	227	4.44
A. subfuscus	1	0.06	36	1.31	0	0	37	0.72
D. sturanyi	0	0	16	0.58	7	0.89	23	0.45
D. laeve	0	0	3	0.10	24	3.06	27	0.53
Total	1572	100	2755	100	784	100	5111	100

Table 2. Frequency of slug occurrence during controls in 1994–1996

Species	1994		1995		1996		Total 1994–96	
	Controls*	%	Controls*	%	Controls*	%	Controls*	%
A. rufus	52	81.25	80	80.81	44	44.00	176	67.18
L. maximus	55	85.94	73	73.74	56	56.00	184	70.23
A. fasciatus	41	64.06	67	67.68	44	44.00	152	58.02
D. reticulatum	35	54.69	74	74.75	40	40.00	149	56.87
A.distinctus	10	15.63	43	43.43	44	44.00	97	37.02
A. subfuscus	1	1.56	20	20.20	0	0	21	8.02
D. sturanyi	0	0.0	8	8.08	6	6.00	14	5.34
D. laeve	0	0.0	3	3.0	19	19.00	22	8.40
Total controls	64	100	99	100	100	100	263	100

* – Number of controls in which a given species was present

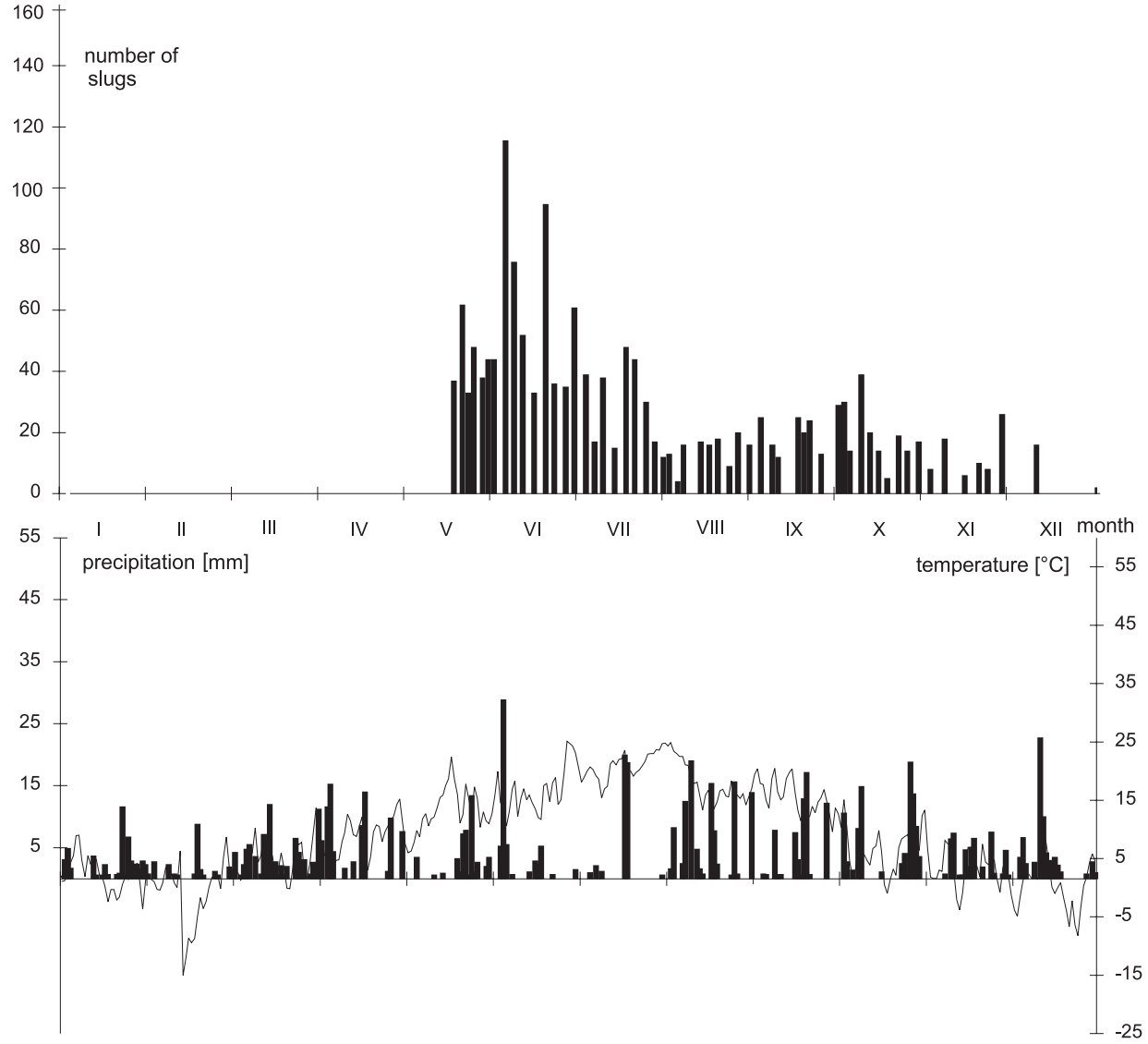

Fig. 1. Slug abundance and weather conditions in 1994

probably associated with the lack of rain and the low air humidity. With increasing rainfall in September, the slug activity increased. Another peak of abundance fell in the first and second decades of October which could result from increased temperatures. Last individuals were caught till the first days of December. In that month the temperature decreased rapidly, to -29°C at the ground surface. In the absence of snow cover, it caused a high mortality of slugs. This was confirmed by the search of the soil and slug shelters in the spring next year. Low temperatures persisted almost till the end of March 1996 (Fig. 3). Because of this first individuals were caught only as late as the second decade of April. With increasing temperatures the abundance of slugs increased gradually. The most numerous slugs (but still much less numerous than in the preceding years) were caught at the beginning and at half of May, and this was followed by a decrease in abundance which persisted till the end of the second decade of August. The slugs were slightly more numerous in the third decade of September and on the turn of October. Generally, the slug abundance in 1996 was much lower (a total of 1096 individuals) than in 1994 (1572 individuals) and 1995 (2755 individuals). The main reason for the low abundance were unfavourable weather conditions in the winter 1995/96. The low air temperature, especially at the ground surface, reaching almost -30°C and the absence of snow cover considerably reduced the slug populations. *A. rufus* and *D. reticulatum* turned out to be the most sensitive to low temperatures. Their proportion, compared to the remaining species, decreased considerably in 1996, mainly because of the high mortality of wintering eggs. However, no negative effect of temperature on *L. maximus* and *A. fasciatus* was observed. After the frosty winter 1995/96 the two species were the most abundant of all the slug community and constituted 28% and 30% collected

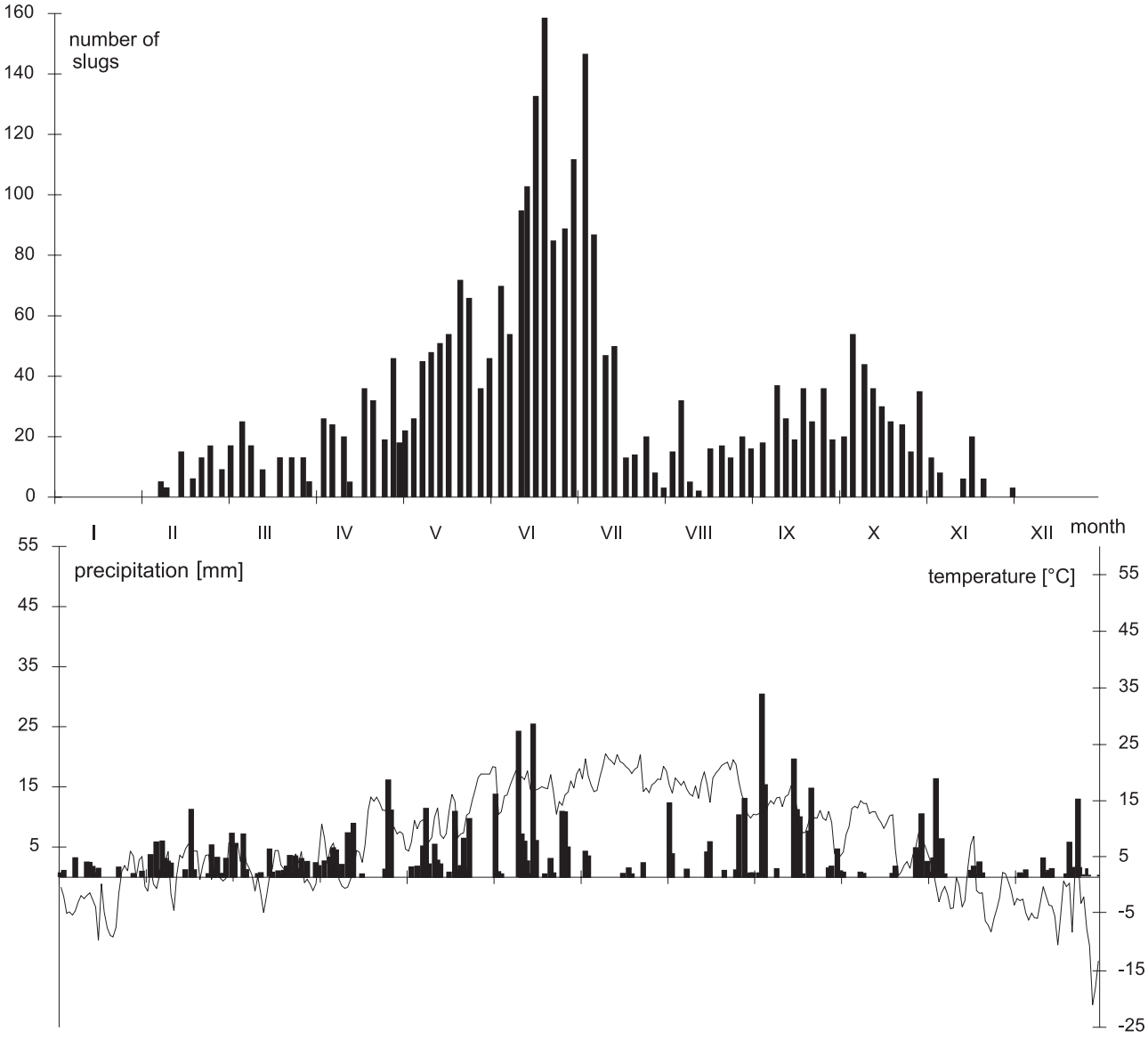

Fig. 2. Slug abundance and weather conditions in 1995

slugs, respectively. Both species winter over most often as adults, *L. maximus* mainly in buildings, municipal conduit pipes and other similar places (WIKTOR 1989), whereas *A. fasciatus* digs deep in litter (WIKTOR 1996). This increases their chances for survival in unfavourable weather conditions (low temperatures and lack of rain).

Since the slug life span and duration of life cycle vary depending on species, these factors, besides weather conditions, could influence the abundance dynamics. In members of the genus *Limax* the life span is a few years, in *Arion* about one or 1.5 year, in *Deroceras* it ranges from a few months to a year (RIEDEL & WIKTOR 1974, WIKTOR 1989, 1996). Figures 4–6 represent the abundance dynamics of the most abundantly recorded slug species in consecutive years. Actually, the graphs of abundance of these dominant species (Figs 4–6) agree fairly well with the overall picture of abundance dynamics (Figs 1–3).

Other factors, besides weather conditions, contributing to slug abundance dynamics, are anthropogenic changes implied by urbanization. This is evidenced by the great differences in percentage of particular slug species between dates of observation, and appearance and disappearance of species of low abundance (*A. subfuscus*, *D. sturanyi*, *D. laeve*). Probably, as a result of interspecific competition and anthropopressure in the studied habitat, some slug species are often replaced by other. The habitat was much diversified (buildings, cultivated plants, bushes, stream, roads) due to which it provided food and shelter for slug species of different requirements. This enabled

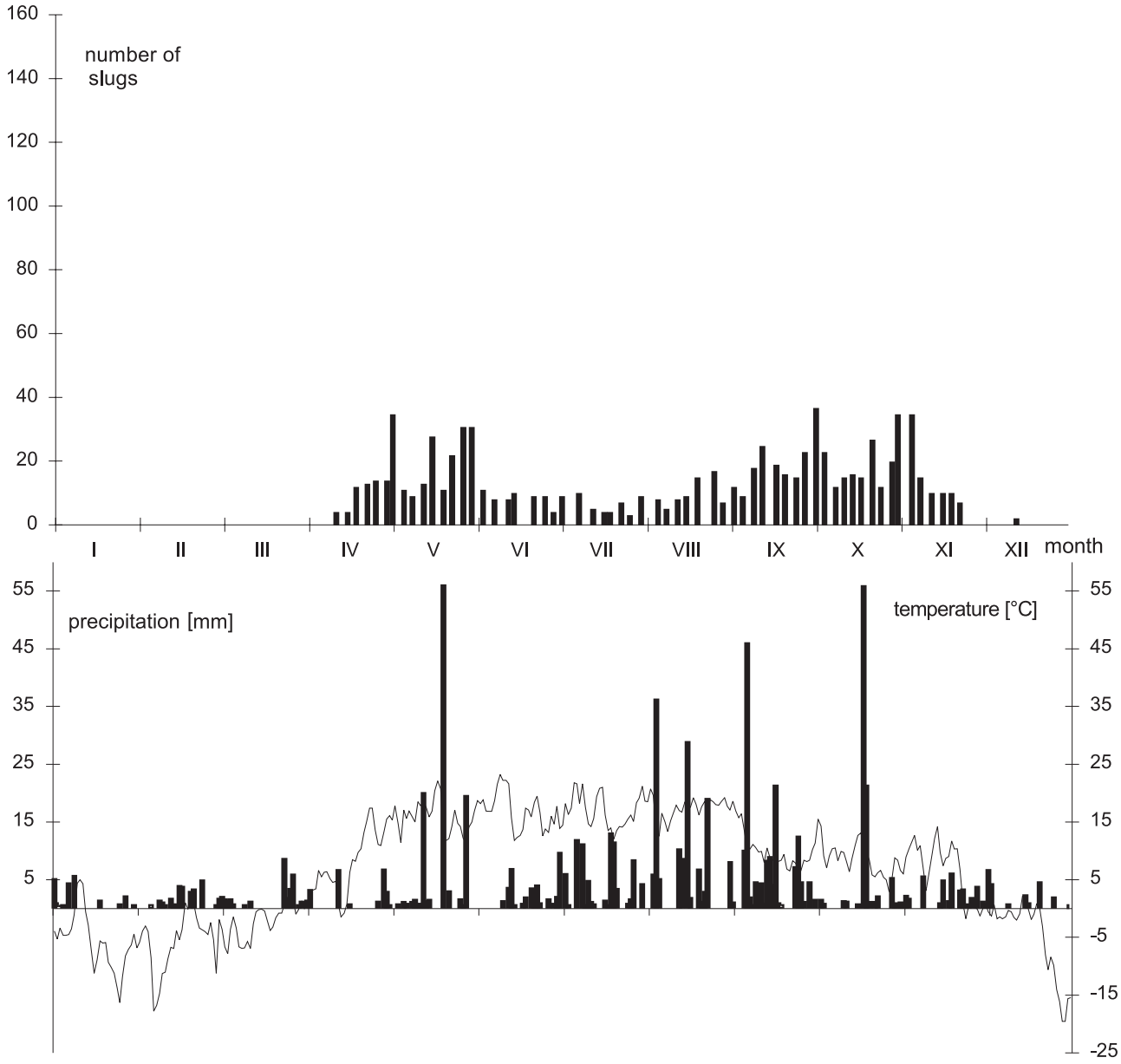

Fig. 3. Slug abundance and weather conditions in 1996

co-occurrence of synanthropic species such as *L. maximus*, *A. rufus*, and species typical of open habitats (*D. reticulatum*, *D. sturanyi*) in a small area. It appears that urban habitats may harbour a slug fauna which, with respect to the number of species, is richer than that of open anthropogenic habitats, such as cultivated fields.

A characteristic phenomenon in the slug abundance dynamics was the presence of two abundance peaks in each of the study years. The first (highest) peak fell in June in 1994 and 1995, and in May 1996. The second peak was observed on the turn of September. Each increase in abundace of the slugs was associated with their increased activity and appearance of juvenile individuals. Migration possibilities of the latter are limited compared to adult individuals. The knowledge of approximate dates of slug abundance peaks may be useful when introducing pest control programmes.

Our study has demonstrated that, based on weather observations, it is to some extent possible to predict appearance of slugs in future vegetation seasons.

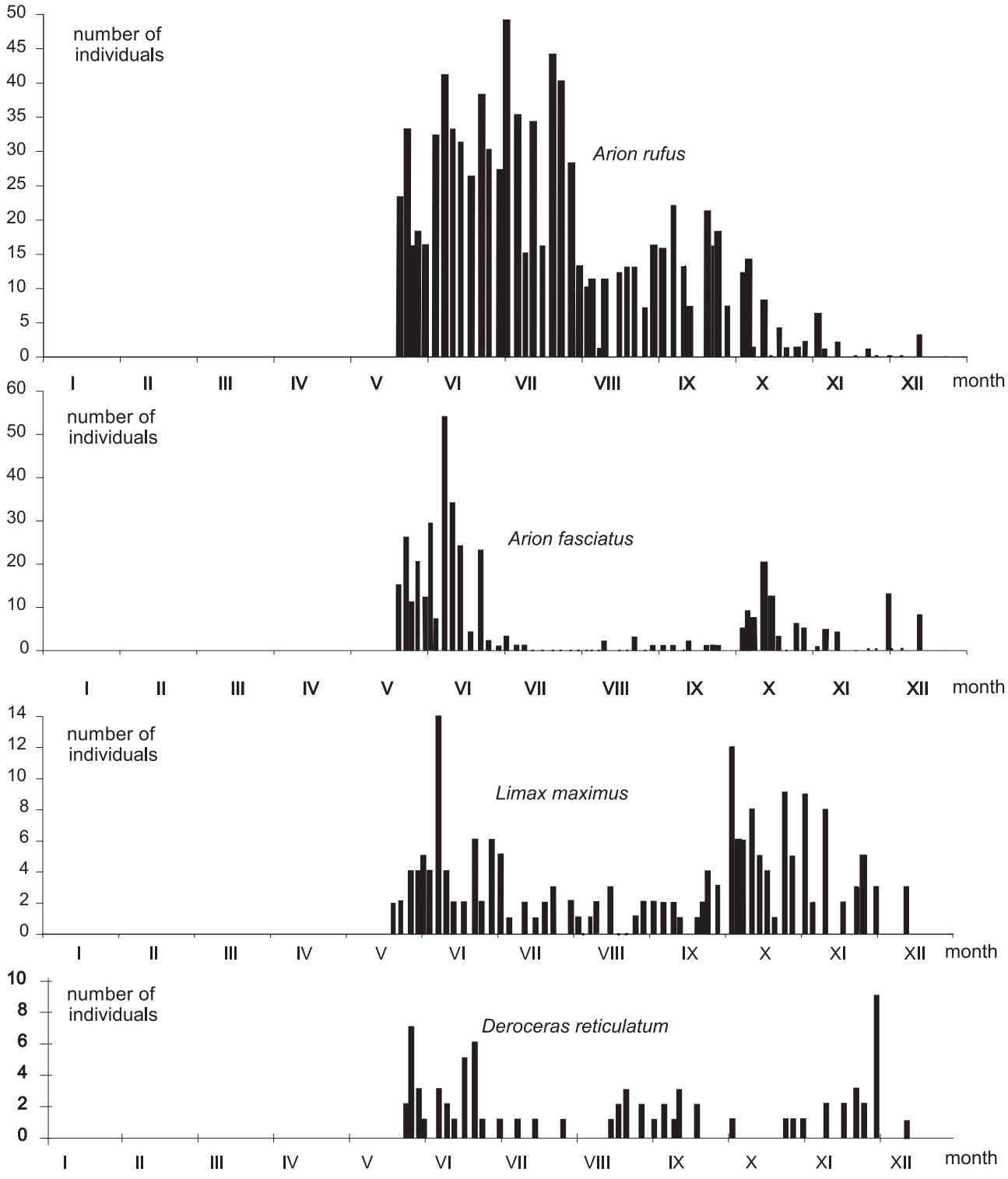

Fig. 4. Dynamics of occurrence of the most abundantly recorded slug species: 1994

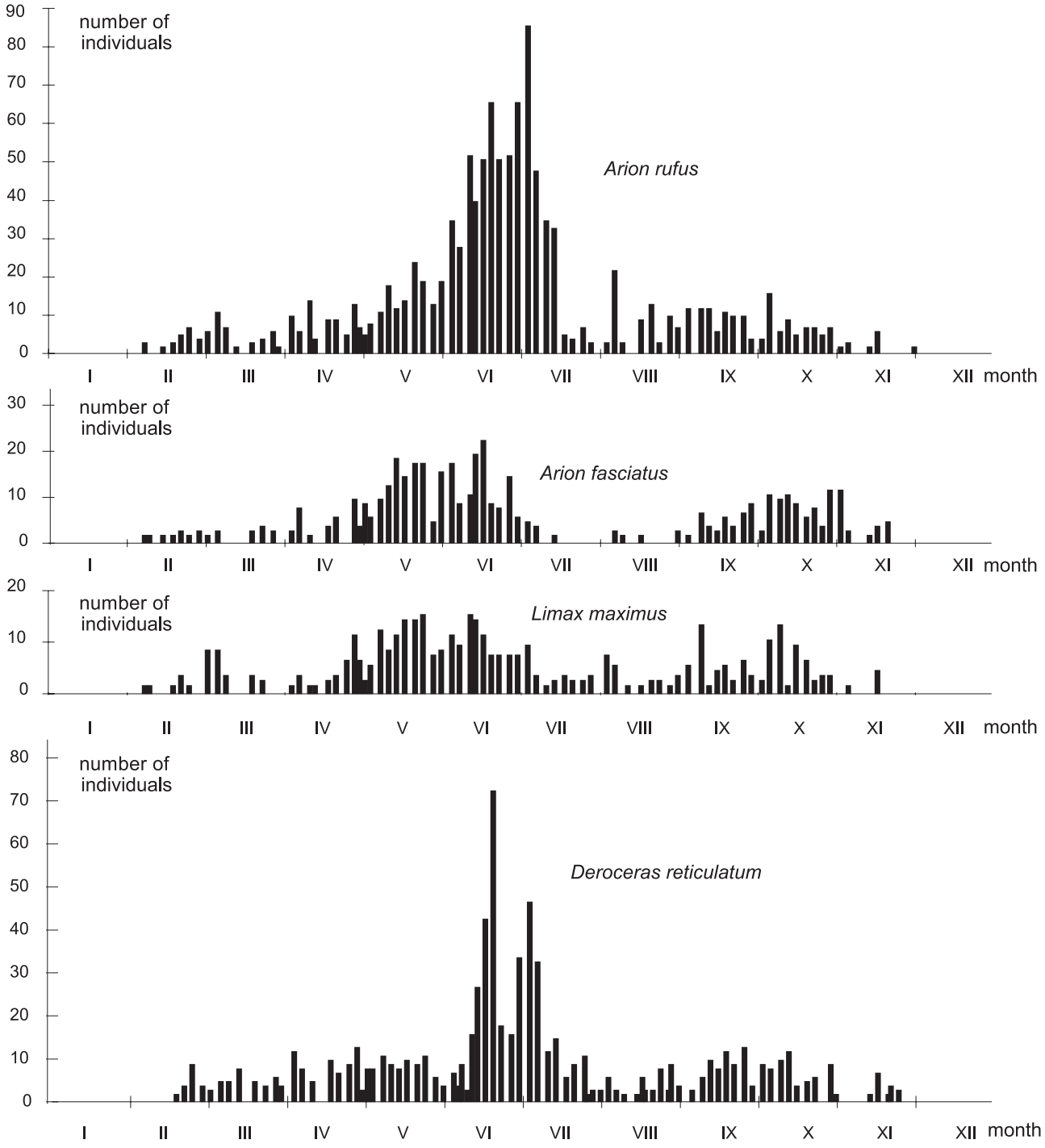

Fig. 5. Dynamics of occurrence of the most abundantly recorded slug species: 1995

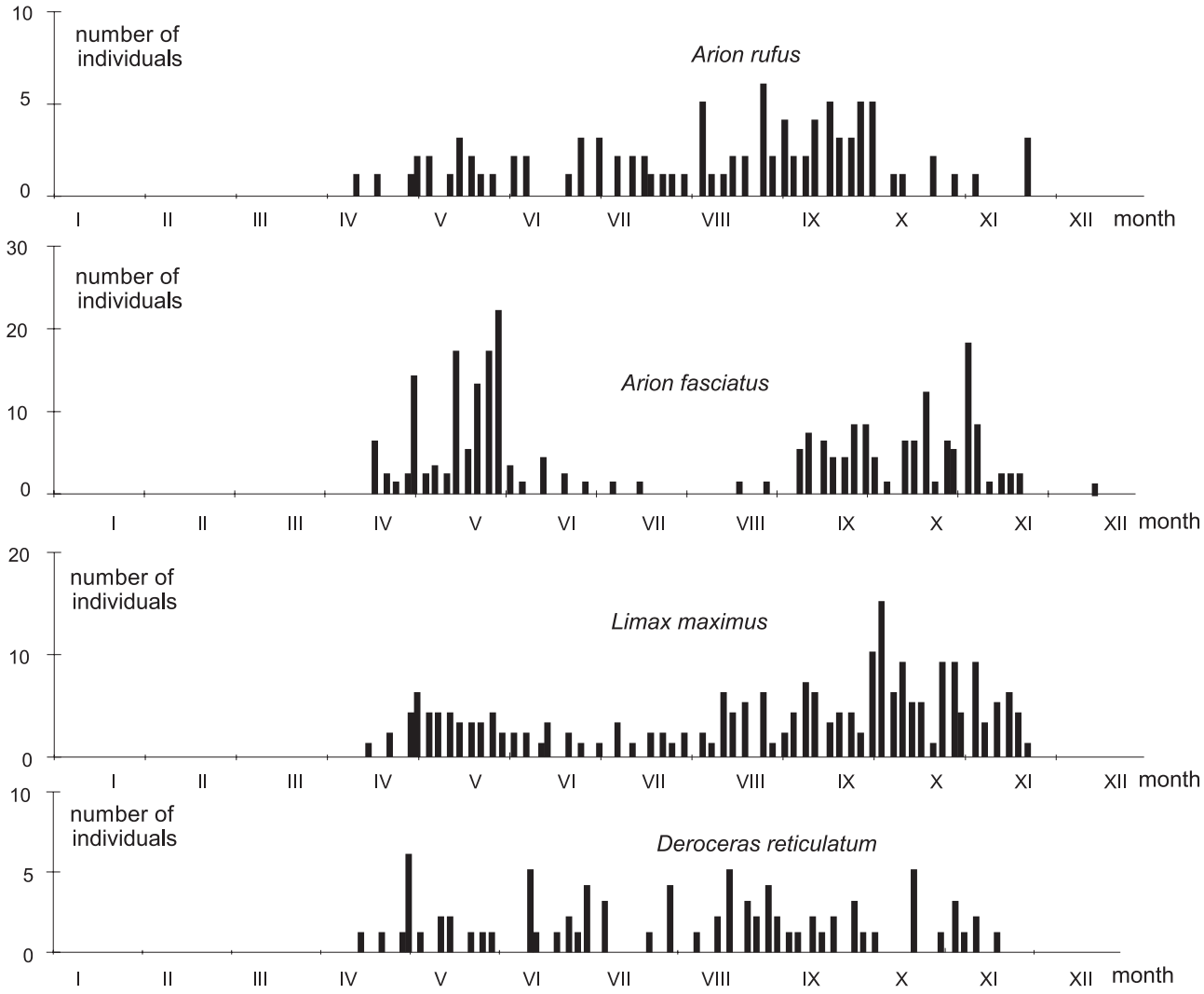

Fig. 6. Dynamics of occurrence of the most abundantly recorded slug species: 1996

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