DEMOGRAPHIC ANALYSIS OF THE MOOR FROG (RANA ARVALIS WOLTERSTORFFI FEJÉRVÁRY 1919) POPULATION IN FRAXINO PANNONICAE — ALNETUM OF THE TISZA BASIN

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Abstract

Data of 3355 R. arvalis specimens collected monthly during the whole season in the period between 1984 and 1988 were analyzed. The capture-recapture method was applied on the 2000 m² sampling area in the alder forest at Tiszaalpár *(Fraxino pannonicae — Alnetum)*.

A gradual increase in density and biomass was observed in the five-year period (505—9800 specimens/ha, 2—45 kg/ha). The home ranges were small and considerable overlapping were observed. Migration plays a significant role in the summer populating of the Alnetum. The distribution of frogs is random, slightly cumulative, the individuals stick to the ticker vegetation structures surrounding the trees. The survival changed from year to year, a high level of juvenile mortality was observed. Not a single specimen reached the age of 4 years. The growth of body mass is intensive, in two years the specimens raech a body mass of 12—20 g, and become sexually mature. The intraspecific competition exerts a considerable, while the interspecific — only an insignificant effect on the moor frog population.

Preserving the intact state of the Tiszaalpári basin is of a primary importance from the nature conservancy point of view. Except for the maintenance of the favourable water supply, the anthropogenic interference should be eliminated. The *Anura* communities, rich in number of species and individuals, are of a decisive importance for birds (Ciconiiformes) trophically based on them.

Introduction

In the field of ecological research of the Tisza river herpetologic investigations are being carried on since 1984 in the Tiszaalpári basin. The object of investigations was in the first place a forest population of *Rana arvalis*. The aim of the investigations was to elucidate the inherents pace-time pattern of the *R. arvalis* population and to clarify the causal background of the changes occurring in it. The determination of demographically important parameters (density, biomass, population structure, growth, home range size, distribution of individuals, migration) besides its scientific merit serves the purposes of herpetofauna conservation, too.

The data found in the literature concerning *R. arvalis* are well-documented but cover only a narrow range of aspects, e.g. Metelan moor frog symposium held in 1987. In its proceedings detailed studies are found on aquatic habitat and reproduction (Clausnitzer 1987, Hübner and Sennert 1987, Loman 1987, Nöllert 1987), migration (Büchs 1987, Hellbernd 1987, Hübner and Sennert 1987) and growth (van GELDER and WIJNANDS 1987, HÜBNER and SENNERT 1987) of *R. arvalis*. Complex demographic investigations are scarce (e.g. LOMAN 1987), for this reason data of other authors on different frog and lizard species are used in the discussion.

Materials and Methods

The investigations were carried out in the period of full activity between 1984 and 1988 in the area of Tiszaalpár-Tőserdő in the Kiskunság National Park. The alder forest *(Fraxino pannonicae — Alnetum)* is situated lower than its surroundings, and is characterized by a permanently ballanced water supply, its soil is sandy, originating from the Danube—Tisza sediment (BANCSÓ 1987). The forest stand comprises 30—50-year-old *Alnus glutinosa* (L.) GAERTNER, occasionally *Fraxinus angustifolia* ssp. *pannonica* Soó et SIMON specimens occur. From spring till June shallow surface water can cover the ground. Due to favourable water supply during the whole vegetation period no noticable changes in the vegetation character of the herb layer are observed, a considerable accumulation of organic matter occurs (BANCSÓ 1987). The forest borders on the one side cultivable lands, and on the other — marshes and meadows, where the reproduction of *R. arvalis* occur. The invertebrate fauna of the forest is extremely rich in species and is characterized with a high number of individuals (the summer biomass is 6—10 g/m^2), thus providing a rich feed supply for the Anura populations.

The long-legged moor frog (*Rana arvalis wolterstorffi* FEJÉRVÁRY 1919) — the dominant *Anura* species in the *Alnetum,* was subjected to a thorough demographic investigation. A species of a broad ecological amplitude, spread mainly in Middle Europe, it is found in various habitats: meadows, forests, reedy — and sedgy marshes, in the vicinity of water (DELY, 1967, GÜNTHER 1985, etc.). *R. arvalis* is a species characterized by a typically terrestrial life form, it seeks water only in the period of laying eggs (MÉHELY 1892, GÜNTHER et *al.* 1969, GLANDT 1986). It is active from March till November, depending on the weather conditions and the northern latitude. Juveniles show diurnal, adults rather nocturnal activity (GÜNTHER et *al.* 1969, GÜNTHER 1985, LOMAN 1987).

The following Amphibia species are wide-spread in the *Alnetum: Bufo bufo* (LINNAEUS 1758) (B=1—5 kg/ha). and *Hyla arborea* (LINNAEUS 1758) (B=2—10 kg/ha). In smaller number of indi-

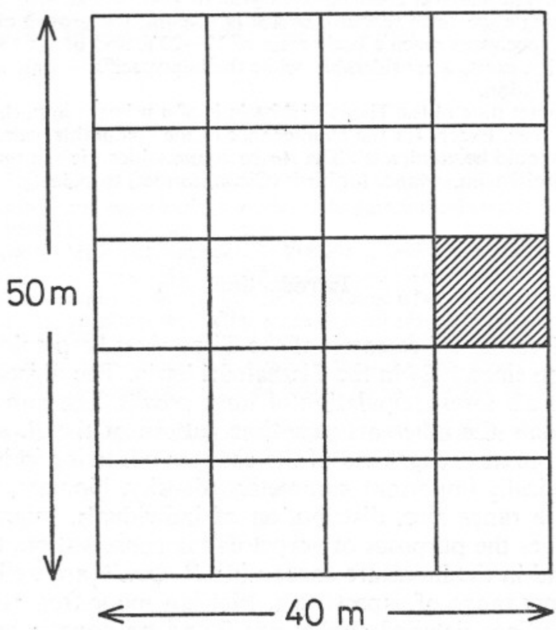

Fig. 1. Schematic map and division of the sampling area (the space coordinates indicated in the 100 m^2 squares)

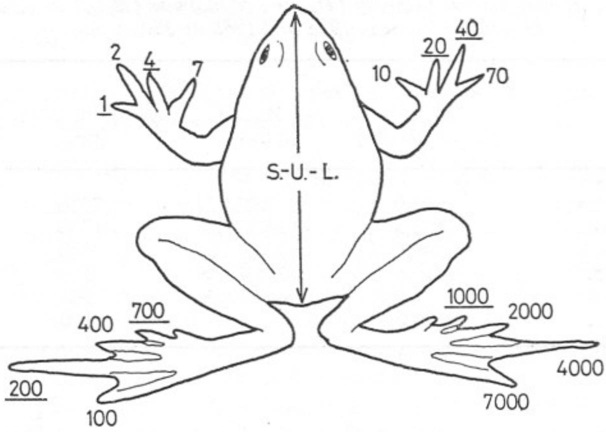

Fig. 2. Individual marking (the numbering of toes from above: e.g. no 1965) and snout-urostyle length of frogs

viduals are found *Triturus vulgaris* (LINNAEUS 1758), *Pelobates fuscus* (LAURENTI 1768), *Bombina bombina* (LINNAEUS 1761), and its green back form, *Rana ridibunda* PALLAS 1771 (4—250 specimens/ha) (GYOVAI 1988).

On the 2000 m^2 sampling area in *Fraxino pannonicae — Alnetum* numbered boards were placed at distances of 10 m from each other. The area marked by four boards was divided in 100 squares with an area of 1 m^2 (Fig. 1), in this way the coordinates of the frogs caught could be specified with an accuracy of 1 m and mapped. In the period between 1984 and 1988 from March till November data have been collected monthly by means of the capture-recapture method.

The sampling area or parts of it were systematically and evenly surveyed, applying manual catching. Frogs were individually marked by pinching off various combinations of distal toe phalanges according to the method of WOODBURY (1956) modified by BRUSSARD (1971, cited in SOUTHWOOD 1978) (Fig. 2). The distinction of age-groups and growth sutdies were based on the recapture data. The sex determination, even in adult species, was possible only in spring and autumn on the basis of the big toe and web sizes (MÉHELY 1892, DELY 1967). The snout-urostyle length was determined with an error of 1 mm, and the body weigth was measured on PESOLA spring scales with an error of 0,1 g.

In the five-year period data of 3355 *R. arvalis* specimens have been analyzed. The density and biomass values were determined on the basis of all specimens collected. The home range values were calculated from the average action radius determined from the series of lengths of recapture. The distribution of individuals was calculated on the basis of the closest neighbour method (CLARK and EVANS 1954, cited in SOUTHWOOD 1978).

The age structure was calculated yearly by pooling the autumn (August—October) density values. The agespecific mortality functions were calculated from the same data by exponential fitting in logarithmic form. The growth curves for different age-groups and sex were constructed on the basis of the body mass of the recaptured specimens.

Results and Discussion

1. Density and biomass

The annual density and biomass of *R. arvalis* showed a considerable increase in the period between 1984 and 1988 (Table 1, Fig. 3). The annual maximal values of density and biomass were observed in different months (Table 1). This depends on the effectiveness of reproduction, the time of juvenile metamorphosis and immigration and the annual pattern of mortality. In the beginning of the year the density and

Table 1. *Annual maximal density (D_{max}) and biomass (B_{max}) of R. arvalis population between 1984 and 1988 at Tiszaalpár*

Date	D_{max} [specimens/ha]	B_{max} (g/ha)	sampling area (m^2)	ave.age of the annual coverage with water
1984. (10. 15.)	505,0	2 221,5	2000	90%
1985. (10. 05.)	1533,3	5 370,0	1200	40%
1986. (06. 26.)	3591,6	20 600,8	600	10%
1987. (08. 15.)	8366,6	22 786,6	300	10%
1988. (07. 04.)		44 963,3	300	10%
08. 13.	9800,0		100	10%

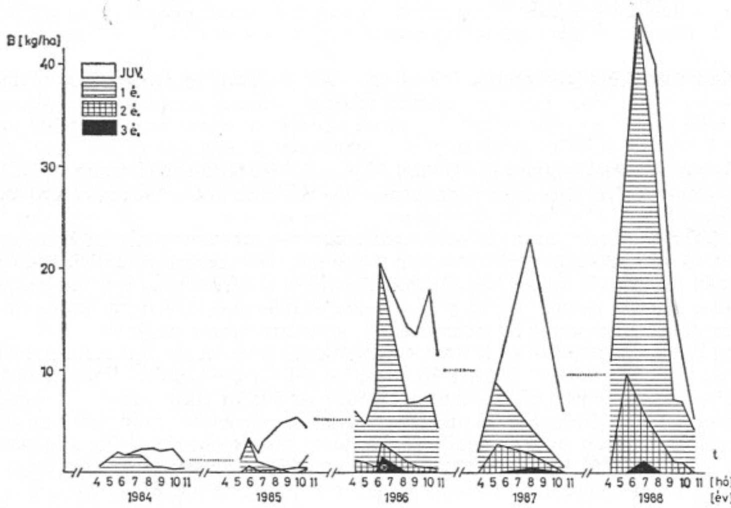

Fig. 3. Biomass of R. arvalis population in different age groups between 1984 and 1988 (... hibernation) 1. year 2. year 3. year [year] [month]

biomass are low, since at that time the adult specimens are either at distant waters where laying of eggs occur, or feeding in the meadows. 20—80% of the ground of *Alnetum* is covered by water till the beginning of summer (May—June). Only after that all the *R. arvalis* specimens return to their terrestrial habitat. The density and biomass of adult specimens are maximal in the beginning of summer (June), decreasing towards autumn, due to continuous mortality, and migration towards the wintering sites. The density of juveniles is maximal in the autumn (August—October), when their metamorphosis and immigration are completed. The values of biomass depend on the density, as well as on the average body mass in different age-groups, these two factor together determine the autumn maximum. In the early autumn the rate of mortality is lower than that of the body mass growth. Similar reasons explain the early autumn maximum observed in the biomass of lizards (TINKLE 1987).

Multiple factors caused the increase in density and biomass observed from year to year. The low density observed in 1984 and 1985 could be connected with the lowest temperatures measured in March in 1982, 1983 and 1984 ($t_{1982} = -2{,}9$ °C, $t_{1983} = -8{,}6$ °C, $t_{1984} = -8{,}7$ °C, which probably reduced the effectivity of reproduction.

The density depends on the larva survival in the preceeding years (LOMAN 1987). It has been shown that the winter cold has no relevant effect on hibernating specimens.

In 1984 and 1985 practically the whole year round the ground of *Alnetum* has been covered by water, and the majority of *R. arvalis* specimens stayed at the dry areas surrounding the alder trees. In the following years (1986—1988) the underground water-level decreased and the forest ground dried. Although the water cover disappeared, the relative humidity of the air remained high, which provided optimal conditions for *R. arvalis* (HÜBNER and SENNERT 1987).

During dry summers some of the frogs inhabiting the surrounding drying out meadows presumably migrate to the forest having optimal microclimatic conditions and a high relative humidity of the air. *Alnetum* is a habitat with a rich feed supply, its complex vegetation provides protection from predators. In 1987 and 1988 an extremely favourable feed supply was due to the overreproduction of *Melasoma aeneum* and the high abundance of small snails and spiders. 80% of these organisms were consumed by *R. arvalis* (unpublished data). The simultaneous favourable effect of the meteorological and trophic factors led to the appearance of the unprecedentally high for the temperate climate frog density and biomass.

Taking into consideration the estimated density of the coexisting species (*Hyla arborea, Bufo bufo,* etc.) the total density of *Anura* species reached in the autumn of 1988 12 000 specimens/ha. The desnity observed in the alder forest surpassed even that of frogs and lizards living in some rain forests (Table 2). According to SCHOENER and SCHOENER (1980) the maximal desnity of the lizard *Anolis sagrei* found on the Bahama Islands was 9700/ha. Density, besides the quality of the habitat, depends also on the geographic latitude, decreasing in general towards the north, due to the shorter activity period (GYOVAI 1986). In Sweeden the density of *R. arvalis* per ha ranged between 140 and 700 (LOMAN 1987).

Table 2. *Comparison of frog and lizard densities in the forests of the Old and New World*

N latitude place	density (speciemens/ha) frogs	frogs and lizards	reference
14° 30′ Thailnad	12—27	115—149	Inger (1980)
10° 26′ Costa Rica	1470	1750	Scott (1976)
9° Panama	2980	4520	Heatwole and Sexton (1966)
8° 42′ Costa Rica	1160	1550	Scott (1976)
1° 37′ Borneo	131	156	Inger (1980)

2. Home range size

The size of the home range is an ecological category providing information on the competition and density factors affecting the population and on the utilization of resources (TINKLE 1967). In 1986 the area of the circular home range of *R. arvalis* ranged between 15 and 20 m² for juveniles, for adults it was on the average 84,6 m² (females: 47,1 m², males: 159,5 m²). The size of the action area depends on the body size, for which reason sex-related differences are observed (TINKLE 1967, RUBY 1978, SCHOENER and SCHOENER 1980, CHRISTIAN and WALDSCHMIDT 1984, GYOVAI 1986). In Sweeden the size of the home range of *R. arvalis* was 260 m^2 (LOMAN 1987). The relatively small home range of the moor frogs found in the *Alnetum* at Tiszaalpár can be explained by the considerable density and high supporting capacity of the forest.

From the reciprocal value of the density it follows that 80—98% of the home ranges overlap, the specimens do not have the territory for their exclusive use. This is to be expected in the cases of high density populations (GYOVAI 1986) and is an indication for a strong intraspecific competition.

On the basis of annual recaptures lasting, usually life-long fidelity and habitat recognition can be demonstrated in adult *R. arvalis* specimens. The adult specimens leave their home ranges every spring but after laying eggs, they return from year to year to their original sites (LOMAN 1987). The pronounced fidelity and habitat recognition was proven in studies on *Atelopus variance* (Bufonidae) by CRUMP (1986) and on lizards (Lacertidae) by STRIJBOSCH et *al.* (1983). The guiding mechanisms of the very precise habitat recognition is still unknown.

3. Migration, colonization

Migration is playing an important role in several aspects of the life of *R. arvalis* population. The larval development and metamorphosis of the moor frog takes place in waters at a considerable distance from the sampling area (200—500 m, $\bar{d}=320$ m). After the metamorphosis is completed a considerable juvenile migration occurs, from the beginning of July mass colonization of the forest is observed. BÜCHS (1987) has proven the existence of three main migration periods for *R. arvalis* (July, August, September). This is related to the non-synchronized metamorphosis taking place from Mid—May till June (HÜBNER and SENNERT 1987). STAMPS (1983) reported on fast populating of the foraging home-sites by juvenile lizards.

The emigration of adult specimens towards waters for laying eggs occurs presumably in spring (GLANDT 1986). The migration of *R. arvalis* does not exceed 600 m, they usually live in the vicinity of waters (HAAPANEN 1970, cited in GLANDT 1986).

Occasionally, the juveniles also leave the *Alnetum* in the cool early spring, and emigrate to the neighbouring warmer meadows and shallow marshes. On March 29, 1986 a migration distance of $57{,}7 \pm 17{,}8$ m from the sampling area was measured. After the warming up of the ground of *Alnetum* and disappearance of the surface water their return is completed. On a year scale the emigration and immigration are of the same order (BÜCHS 1987, HELLBERND 1987).

4. Distribution of individuals

The monthly distribution of *R. arvalis* individuals as observed in 1984 was — with small deviations — random, slightly cumulative ($\bar{r}^2 \cdot m=0{,}177$—$0{,}282$). The values measured in August in different years were as follows: 1984 — 0,197; 1985 — 0,344; 1986 — 0,391; 1987 — 0,209; 1988 — 0,114. No correlation could be found between the annual changes of the distribution of individuals and the increase in density.

Similar distribution was demonstrated for alder trees in the sampling area. The architecturally complex herbaceous vegetation surrounding the root-head located above the ground level has in fact a relevant effect on the space distribution of frogs. A considerable enrichment of the surroundings of the alder trees with *R. arvalis* specimens is observed. Here their density is 8,99 times higher as compared to the bare, damp or covered with leaf-detritus areas among the trees.

The distribution of forgs is determined basically by the complex structure of the feeding and hiding sites. Such places in general not only help to successfully avoid predators but they are at the same time feed sources (SCHOENER and SCHOENER 1980, STAMPS 1983).

5. Age structure

The age structure of *R. arvalis* population changes from year to year (Fig. 4, Table 3). The annual survival of juveniles — with the exception of 1987 — is low, less than 20%. The major part of juveniles perish in larval stage and during immigration. Presumably, the major factor of mortality is predation which affects in the first place the small body size juveniles. This is supported by the signs of encounters with predators observed in 2% of the juveniles (back injuries, leg loss, etc.). Presumably, an extremely high predators' pressure is exerted on the *R. arvalis* population which ensures a proper regulation of the high density population. High mortality was demonstrated in the period following the birth in *R. temporaria* by SMIRINA (1980).

The chances of adult specimens for survival are better, though not a single specimen reached the age of 4 years. The mortality functions and histograms showed patterns changing from year to year (Fig. 4, Table 3). The potential predators in

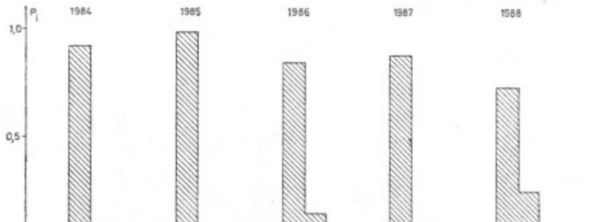

Fig. 4. Age structures of R. arvalis population between 1984 and 1988 year of life [year] [period of life]

Table 3. *Annual age-specific mortality functions of R. arvalis population p_i: relative frequency (in autumn $\Sigma p_i = 1$), t: age in year p: significance (ns — not significant)*

Year	Mortality function	p
1984	$\ln p_i = 1{,}15e^{-2{,}46t}$	ns
1985	$\ln p_i = 0{,}76e^{-2{,}82t}$	$p < 0{,}1$
1986	$\ln p_i = 1{,}14e^{-2{,}28t}$	$p < 0{,}1$
1987	$\ln p_i = 0{,}45e^{-1{,}65t}$	$p < 0{,}02$
1988	$\ln p_i = 0{,}90e^{-1{,}88t}$	ns

Alnetum are: heavy-bodied Carabidae, parasitoid Calliphoridae, *Rana ridibunda* (proven, unpublished), *Natrix natrix, Aves.* In Sweeden the annual survival of *R. arvalis* s higher, annual 60%, predators being the main mortality factor (LOMAN 1987).

In 1984, 1985 and 1986 R. arvalis reached sexual maturity presumably at the age of 2 years. In 1987 and 1988 due to the slower growth probably only a small fraction of 2-year-old and the 3-year-old specimens were involved in the reproduction. In general *R. arvalis* (ssp. *arvalis*) reach sexual maturity at the age of 3 years (GÜNTHER et *al.* 1969, LOMAN 1987), some females even at the age of 4 (LOMAN 1987).

In 1988 the average number of eggs in an egg-clump was 791,6±300,7. The considerable scattering indicates the presence of small and big clumps (450—600 eggs and 1100—1200 eggs). Presumably, the smaller ones were layed by the heavy-bodied (>50 mm) 2-year-old females, whether the bigger ones — by the 3-year-old (>60 mm) females.

In reptilia several authors found a positive correlation between the number of eggs layed and the body size (TINKLE 1972, AVERY 1975, IVERSON 1979, VITT and LACHER 1981, GYOVAI 1986), in *Rana graeca* (BEŠKOV (1970).

6. Growth

The growth of *R. arvalis* specimens is intensive, the age groups are easily distinguished on the basis of body mass (Fig. 5). The growth stops in October — before the hibernation, — the body mass decreases. The growth rate of frogs decreases in function of age (SMIRINA 1980, WHEATER 1985, LOMAN 1987). The body mass growth curves for lizards show a downward tendence and have a sigmoid shape (van DEVENDER 1978, GYOVAI 1986), which in principle is valid for frogs as well. The body mass growth of *R. arvalis* in the sampling area shows a linear tendency, due to the

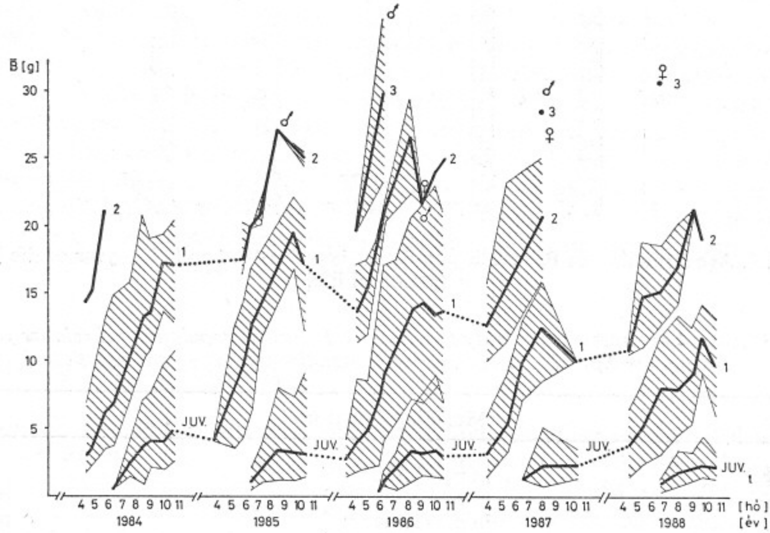

Fig. 5. Average body mass growth in different age groups of R. arvalis population between 1984 and 1988 (heavy line: average values, striped area: minimum-maximum) [month] [year]

fact that the adults perish at the age of 3 years, before reching the potentially maximal (asymptotic) size (Fig. 4,5).

Presumably the density dependent factors controlling the populations (limited resources under the conditions of increasing density) led to the considerable decrease in the growth rate in the period between 1985 and 1988 (Fig. 6). This tendency was particularly pronounced in the one-year-old generation, in which the average values for 1988 were by 40% lower than those for 1985.

The body size segregation within the age groups by means of the continuous resource distribution presumably plays a significant role in minimazing the intraspecific competition (Fig. 5). Positive correlation is observed between the size of feed-animals and the body size (GYOVAI 1988), in lizards (ROSE 1976, PIANKA and HUEY 1978, SCHOENER et *al*. 1982, GYOVAI 1986). In *Rana temporaria* within the same age groups 3,5-fold differences in the body mass have been observed by SMIRINA (1980).

By the method of capture-recapture it was established that the growth of males is more intensive than that of females (Fig. 7). E.g. in 1986 the body mass of one-year-old male reached that of a two-year-old female (Fig. 5). Contrary to these ob-

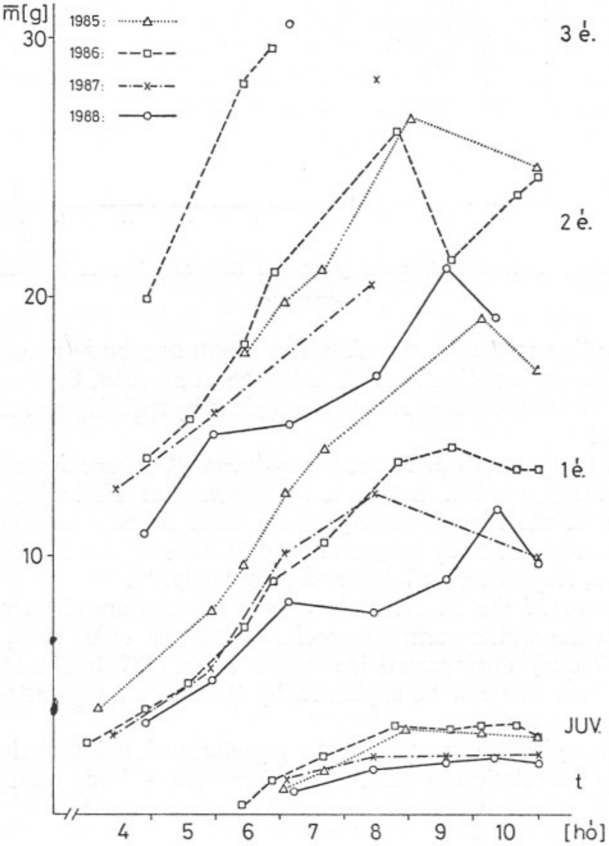

Fig. 6. Changes in the average body mass in different age groups of R. arvalis in 1985—1988
3. year 2. year 1. year [month]

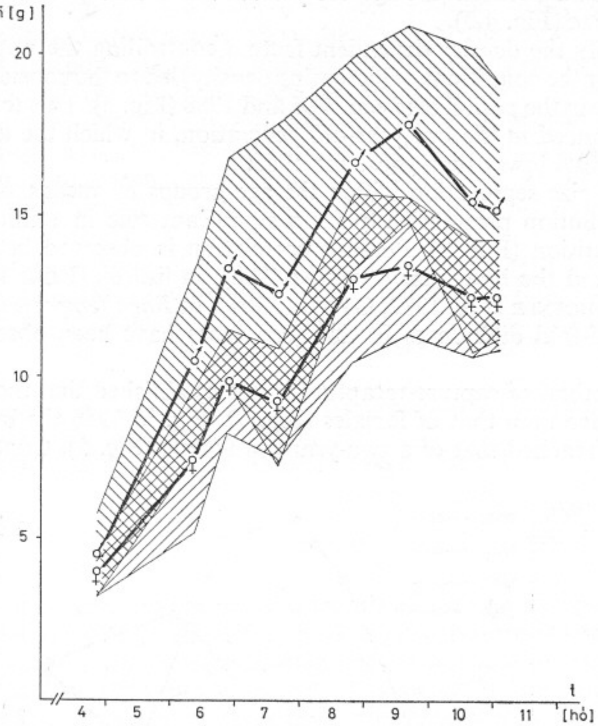

Fig. 7. Sex-dependent average body mass growth of R. arvalis in 1986 (striped areas: scattering) [month]

servations according to the literary data the length and body mass of female frogs exceed that of the males (MÉHELY 1892, GÜNTHER et *al.* 1969, ELMBERG 1987). However, the bigger size of the females could be explained by their higher survival as compared to the males.

The maximal body length of *R. arvalis wolterstorffi* subspecies observed in Hungary is 76,5 mm (DELY 1967). In 1986 in the *Alnetum* at Tiszaalpár the body length and body mass of the biggest three-year-old male found was 70 mm and 35,3 g, respectively; in 1988 the body length and body mass of the biggest three-year-old female measured, respectively, 67 mm and 30,6 g (Fig. 5).

The specimens of the *R. arvalis* arvalis subspecies are shorter but thicker-set as compared to the wolterstorffi subspecies (GÜNTHER et *al* 1969, TOMASIK 1971, HELLBERND 1987, etc.). Their growth is slower (LOMAN 1987) but beside the genetically determined features this can be explained by the shorter vegetation period of the northern habitats as well.

The morphological parameters of the population inhabiting the sampling area are expressed by the relation $m = 5.83 \cdot 10^{-5} \cdot L^{3.107}$ (m — body mass in g, L — body length in mm).

7. Intra- and interspecific competition

Among the specimens of the high density population of *R. arvalis* the competition can develop in the first palce in relation to feeding. The feed size shows a positive coorealtion with the specimens' body length (GYOVAI 1988). The intraspecific interactions within the age groups are significant in the high density juveniles and one-year-old subadults (Fig. 4, 6). The metamorphosis is protracted (from May till June). This is proven as well by the three juvenile migration periods observed (BÜCHS 1987). For these reasons considerable variations are observed in the developmen t and body size of the specimens of different ages and sex. The strong body size segregation of the juveniles and one-year-old specimens (Fig. 5) reduces to a certain extent the strong feed-competition within the age group (wide range of resource utilization).

The intraspecific feeding interactions between juveniles and adults are presumably minimal. This is justified by the segregation of their activity in time and by the insignificant overlapping of feed sizes for different age groups (GYOVAI 1988). The growth of juvenile specimens is regulated by the density dependent intraspecific competition.

Contrary to the coexisting *Anura* populations the interspecific competition for *R. arvalis* is probably minimal, it even could not be demonstrated. *R. arvalis* is vertically segregated from *Hyla arborea* characterized by arboreal life form. Effective interspecific competition with *Bufo bufo* and *Pelobates fuscus,* species characterized by nocturnal life form and passive prey-capture strategy, is presumably minimal, too.

8. Nature conservancy aspects

R. arvalis characterized by a broad ecological amplitude is at present a general frog species in Hungary. However, in a number of places in Western Europe it is endangered by extinction and its short-legged subspecies *(Rana arvalis arvalis)* is on the red list (HÖLZINGER 1987, HÜBNER and SENNERT 1987). As far as its aquatic habitat is concerned it is a stenök species, for its development it requires shallow, oligotrophic moor (HÜBNER and SENNERT 1987). Among the endangering factors the water acidification (CLAUSNITZER 1987) and the enrichment, even shading of the coast structure (NÖLLERT 1987) can be mentioned. *Anura* is endangered by the application of pesticides and intensive agriculture (HÖLZINGER 1987). E.g. in the case of lizards seemingly insignificant changes in the original vegetation can lead to drastic changes (GYOVAI 1986).

The herpetofauna in the Tiszaalpár basin is exceptionally rich, both quantitatively and qualitatively, which indicates at present it intact state. The vegetation, microclimatic and trophic conditions of *Alnetum* are favourable for the *Anura* populations. The frogs developing in the neiboughring marshes are of decisive importance as a trophic basis for the Ciconiiformes (*Ardeola ralloides, Egretta garzetta, Platalea leucorodia,* etc.), which represent the high nature conservancy value of the region.

The high density *R. arvalis* population in the *Alnetum* serves as a species reservoir. The maintenance of such a stable habitat is justified both from the nature conservancy and forestry point of view. In the future, except for providing an optimal water supply, the region should be protected from any other anthropogenic effect. By keeping the state of the Tiszaalpár region close to natural, one of the most valuable *Anura* habitat in Middle Europe should be by all means preserved.

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Mocsári béka (Rana arvalis wolterstorffi Fejérváry, 1919) populáció demográfiai analízise a Tiszavölgy Fraxino pannonicae-Alnetumában

GYOVAI F.

Kivonat

Az 1984—1988 évek teljes szezonjára kiterjedő havonkénti gyűjtések során 3355 R. arvalis egyed adatai lettek feldolgozva. A tiszaalpári éger erdőben *(Fraxino pannonicae-Alnetum)* kijelölt 2000 m²-es mintaterületen a jelölésvisszafogás módszer volt alkalmazva.

A denzitás- és biomassza értékek folyamatos növekedést mutattak az 5 év során (505—9800 egyed per hektár, 2—45 kg per hektár). A home range méretek kicsik és nagy átfedéseket mutatnak. Az *Alnetum* nyári benépesülésében a migráció nagy szerepet tölt be. A békák diszpergáltsága random kissé kumulálódó, az egyedek kötődnek a fákat övező vegetációs struktúrákhoz. A túlélés évről évre változott,a juvenilisek mortalitása nagyfokú. A 4 éves kort egyetlen egyed sem érte meg. A testsúly növekedés igen intenzív, az egyedek két év alatt elérik a 12—20 grammos testsúlyt és ivaréretté válnak. Az intraspecifikus kompetíció jelentős, az interspecifikus azonban jelentéktelen hatást gyakorol a mocsári béka populációra.

Természetvédelmi szempontból elsődleges a tiszaalpári medence érintetlenségének biztositása. Az optimális vízviszonyok fenntartásán kívül az antropogén beavatkozásokat meg kell akadályozni. A páratlanul gazdag faj- és egyedszámú *Anura* közösségek a trófikusan rájuk épülő madarak (Ciconiiformes) számára kulcsfontosságúak.

Демографический анализ популящий болотной лягушки (Rana arvalis wolterstorffi Fejérváry, 1919) в ольховом лесу Тисаалпари Fraxino pannonicae-Alnetnm

Ф. Дьоваи

Резюме

Обработаны данные 3355 особей *R. arvalis,* пойманных в результате ежемесячного сбора образцов, распространяющегося на весь сезон в период 1984—1988 гг. В ольховом лесу у Тисаалпари *(Fraxino pannonicae — Alnetum)* на изучаемом участке прлощадью в 2000 м² применяли метод маркирования и исследования вновь пойманных особей.

За пятилетний период наблюдалось постоянное увеличение плотности и биомассы (505—9800 инд га, 2—45 кг/га). Размеры областей обитания особей были невелики и наблюдалось их значительное перекрывание. В летнем заселении *Alnetum*-а миграция играет значительную роль. Распределение лягушек беспорядочно, с известной тенденцией кумуляции; особей привлекают густые растительные структуры, окружающие деревья. Выживание менялось из года в год, гибель молоди была значительной. Ни одна из особей не достигла возраста 4 лет. Увеличение массы весьма интенсивно. Масса особей за два года увеличивается до 12—20 г и они достигают половой зрелости. Внутривидовая конкуренция имеет значительное, в то время как междувидовая — лишь незначительное влияние на популяцию болотной лягушки.

С точки зрения охраны окружающей среды важно сохранить заповедность бассейна Тисаалпари. Кроме обеспечения благоприятного водного режима следует исключить все другие антропогенные влияния. Сообщества *Anura*, отличающиеся исключительным богатством видов и числа особей, играет решающую роль для птиц *Ciciniiformes,*, являясь их трофическим базисом.

Demografijsko izučenje populacije Rana arvalis wolterstorffi (Fejérváry, 1919) u šumskoj zajednici Fraxino pannonicae-Alnetum

GYOVAI F.

Abstrakt

Sa mjesečnom skupljanjem autor je obradio podatke od 3355 primeraka Rana arvalis u periodu 1984—1988 god. Metoda „označavanje-ponovno hvatanje" je bila primjenjena u zajednici *Fraxino pannonicae-Alnetum* na teritoriji od 2000 m²-a.

Tokom ove pet godine denzitet i biomasa su se stalno uvećavali (505—9800 primerak kroz hektara, 2—45 kg kroz hektara).

„Home range" razmerke su bile male i pokazali su velike preklapanje. U letnjoj naselji *Alnetum,* migracija je imala velikog značaja.

Disperzitet žabe je bio random, malo kumuliran, jedinke su se jako vezali za vegetaciju.

Svake godine se promenio procjenat preživljenja, mortalitet, juvenilnim jedinkama je bila dosta velika.

Nijedna žaba nije dostigao četvrtu godinu. Povećanje tjelesne težine je bilo intenzivno, jedinci su postigli 12—20 grama preko dvije godine i postali su spolno zrijeli.

Intraspecifična kompeticija ima veliki ali interspecifična kompeticija nema značajniji utjecaj za populaciju Rana arvalis.

Za zaštitu prirode je primarna metoda da bazen kod Tisaalpara da bude netaknuta.

Optimalni vodeni balans da bude održana i ukinuti antropološke utjecaje.

Retko obogaćena fauna *Aure* je neophodna za zajednicu Ciconiiformes.