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# PREY SELECTIVITY IN WELS (*Silurus glanis*) AND AFRICAN CATFISH (*Clarias gariepinus*)

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## Summary

The experiments aimed at prey selectivity in two Siluriformes predators — African catfish, *Clarias gariepinus*, and wels, *Silurus glanis*, were performed under laboratory conditions. Prey fish (12–22% TL of predator) were submitted to one–year–old African catfish (~220 g) and wels (~150 g) originating from intensive culture, *ie* with no previous experience with live fish food. In African catfish, negative selectivity (avoidance) was shown for Nile tilapia (*Oreochromis niloticus*) and topmouth gudgeon (*Pseudorasbora parva*) whilst rudd(*Scardinius erythrophthalmus*) and sunbleak (*Leucaspius delineatus*) were preferred (positive selectivity). The intensity and efficiency of African catfish predation were quite low because its feeding strategy is based rather on prey searching than hunting. Prey fish, wounded and/or dead from its clumsy attacks, were sonsumed preferably overnight. Not one successful attack of African catfish on healthy prey fish was registered. The SGR and FCR of clarias fed live fish were 0.39%. day$^{-1}$ and 4.73 respectively. In wels, strong negative selectivity (avoidance) was proved for roach (*Rutilus rutilus*) and topmouth gungeon, and lower avoidance for Prussian carp (*Carassius auratus gibelio*) and chub (*Leuciscus cephalus*). Asp (*Aspius aspius*) were found to be low preferred but high preference was shown for sunbleak, rudd and bitterling (*Rhodeus sericeus*). Both catfishes preferred smaller prey fish during the 10–day experimental period whilst those which remained non–consumed belonged to the mean or above–mean size categories.

*Key words: predation, prey selectivity, wels, African catfish, tilapia*

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## *INTRODUCTION*

The European catfish — wels, *Silurus glanis* Linneaeus, 1758, is considered as an important predatory fish species with a good prospects in water quality biomanipulation (Lusk et al., 1983, Raat, 1990, Adámek, 1993a). The analyses of wels stomach content which were published from Czech (Hrbáček et al., 1952, Hruška and Oliva, 1953), Slovak (Sedlár and Žitnan, 1977), Polish (Horoszewicz, 1964), Romanian (Vasiliu and Popescu, 1943) and Russian rivers (Orlova and Popova, 1986) confirm its strong predatory feeding behaviour. However, as proved in several recent studies, wels possess also very good growth performance when cultured in ponds (Mareš et al., 1996), cages (Bogut et al., 1989) or intensive indoor recycling units (Fiala et al., 1996).

Under conditions of the temperate climate, African catfish — clarias /*Clarias gariepinus* (Burchell, 1822)/ are cultured in warm–water facilities. However, they can be successfully grown in this region in outdoor basins and ponds over the summer period (Adámek and Sukop, 1995). African catfish are considered as benthivores under natural conditions (Adebisi, 1981, Doergeloh, 1994) with certain tendency to predatory behaviour (Bruton, 1979a, b). When farming African catfish in biculture with tilapia, they can play a role of police fish controlling tilapia recruitment (Middendorp, 1994, Lazard and Oswald, 1995, De Graaf et al., 1996). Their predatory behaviour results in considerable cannibalism in dense stocks under controlled conditions (Hecht and Appelbaum, 1988). The ethology and physiology of African catfish predation were described by Lissman and Machin (1963), Bruton (1979a, b) and Britz and Pienaar (1992).

There is known that only several fish species are regularly being found in stomachs of predatory fishes under natural conditions, and it is usually difficult to judge to what extent this is a result of prey species density, their ability to hide or their preference by a predator. Thus, the aim of this study was to compare the prey selectivity in young wels and African catfish under laboratory conditions where the effects of prey species density and their possibility to hide were eliminated. Similar experiments were already performed with Nile Tilapia (Adámek, 1993b) and largemouth bass, *Micropterus salmoides* (Adámek and Siddiqui, 1996).

## *MATERIAL AND METHODS*

The experiments were performed during winter period (January — February) with 0+ wels (1993) and African catfish (1994), originating from artificial stripping and indoor intensive culture in a recycling system. This means that the experimental fish had no previous experience with fish as a food. They were separated individually in 100 l aquaria provided with artificial aeration.

Water temperature, D. O. content and pH value were monitored several times during the experimental period at approx. 9 a. m. Fish were measured and weighed always before and after the experimental period which lasted for 10 days. The basic environmental parameters and fish data are presented in Tab. 1. The wels were two albino fish, the African catfish originated from the domesticated strain which was introduced into the Czech Republic from Netherlands in 1986 (Adámek and Kouřil, 1996).

*Table 1. Environmental parameters and experimental fish characteristics (mean ± S. D.)*

*Tablica 1. Parametri okoliša i značajke pokusnih riba (prosjek ± S. D)*

| Parameter | Unit | Wels | | African catfish | |
|---|---|---|---|---|---|
| Environment | | n | | n | |
| Temperature | °C | 7 | 25.3±0.8 | 13 | 22.4±1.6 |
| Oxygen | $mg{\cdot}l^{-1}$ | 7 | 6.31±0.73 | | |
| pH | | 8 | 8.03±0.15 | | |
| Fish | | | | | |
| Total length | mm | 6 | 276±19 | 4 | 286±20 |
| Weight | g | 6 | 138.6±31.2 | 6 | 186.7±37.2 |
| Mouth width | mm | | | 4 | 18±1 |

Predators starved for 24 hours before the experiment and prey fish were submitted in one batch (day 0). The numbers of prey (which usually were 10 fish of each species in every replication) and their size are presented in Tab. 1. In the morning hours of the days 3, 4, 7, 10, and 2, 3, 5, 7, 9, 10 (in wels and African catfish, respectively), remaining prey fish were collected, anaesthetized with Quinaldine (Merck–Schuchard, FRG, 0.05 ml. $l^{-1}$), counted, measured and weighed and after recovery released back to the experimental tank. The experiment was conducted in 4 replications with each predator. After the experimental period lasting for 10 days, predators were measured and weighed to assess their length growth and specific growth ratio (SGR) according to formula:

SGR (%. $day^{-1}$) = 100. (In $W_t$–In $W_i$)/t,

where $W_t$ — final fish weight in g, $W_i$ — initial fish weight in g, t — days of experiment. Food conversion ratio (FCR) was also calculated from the total weight of consumed fish (w) and the weight increment of a predator (W) as:

FCR = w/W

Feeding selectivity was calculated using the Ivlev's selectivity index E (Jacobs, 1974):

E = (r — p)/(r + p),

where r — proportion of certain prey item taken by predator, p — proportion of that prey item present in the offer. Positive values (0 to +1) mean that the item is preferred, whilst negative ones (–1 to 0) mean that the particular item is avoided. The values about zero show that the item is consumed in accordance with its density in the surrounding environment.

## *RESULTS*

Within the ten–day period, all sunbleak, rudd and bitterling were consumed by wels (E = +0.19). Positive selectivity index was found also for asp (E = +0.10), whilst the other prey fishes were avoided with different approach, chub (E = –0.10) least, and roach most (E = –0.37) among them. Sixty per cent of sunbleak were consumed during first four days, while all rudd and topmouth gudgeon remained uneaten during this initial period of time (Fig. 1). No significant changes were found in length and weight parameters of consumed prey fish with the time course during the experimental period (Figs 2 and 3).

*Table 2. Numbers and sizes of prey fish with Ivlev's selectivity indices E in parentheses.*
*Abbrev.: We — wels, A. c. — African catfish*
*Tablica 2. Broj i veličine ribljega plijena s indikatorima selektivnosti E u zagradama*

| | n | | Total leight (mm) | | Weight (g) | | Height (mm) |
|---|---|---|---|---|---|---|---|
| Prey/Predator | We | Ac | We | Ac | We | Ac | Ac |
| Chub<br>*Leuciscus cephalus* | 30<br>(–0.10) | | 61±4 | | 1.9±0.4 | | |
| Prussian carp<br>*C. auratus gibelio* | 26<br>(–0.15) | | 62±6 | | 3.3±1.0 | | |
| Rach<br>*Rutilus rutilus* | 16<br>(–0.37) | | 53±6 | | 1.5±0.5 | | |
| Topmouth gudgeon<br>*Ps. parva* | 30<br>(0.18) | 40<br>(–0.13) | 57±7 | 46±6 | 1.6±0.7 | 0.7±0.2 | 7±1 |
| Asp<br>*Aspius asius* | 30<br>(+0.10) | | 61±3 | | 1.8±0.3 | | |
| Sunbleak<br>*L. delineatus* | 27<br>(+0.19) | 40<br>(+0.11) | 66±6 | 54±6 | 2.0±0.7 | 1.0±0.4 | 8±1 |
| Rudd<br>*Sc. erythrophthalmus* | 10<br>(+0.19) | 38<br>(+0.18) | 48±6 | 48±5 | 1.1±0.6 | 0.9±0.4 | 9±1 |
| Bitterling<br>*Rhodeus sericeus* | 11<br>(+0.19) | | 48±9 | | 1.5±0.9 | | |
| Nile tilapia<br>*O. niloticus* | | 40<br>(–0.26) | | 45±2 | | 1.4±0.3 | 12±1 |

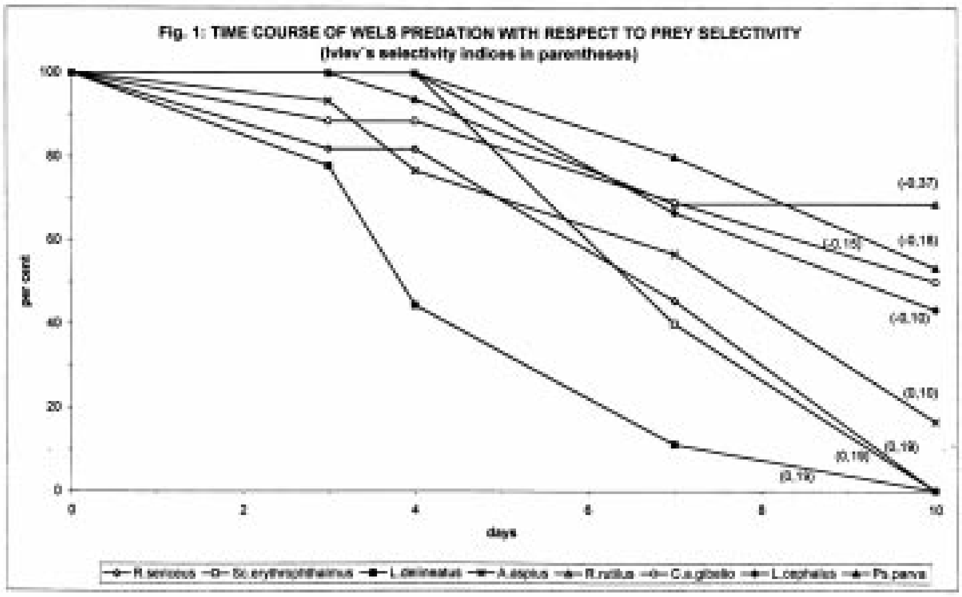


*Figure 1: Time Course of Wels Predation with Respect to Prey Selectivity (Ivlev's selectivity indices in parentheses)*
*Slika 1. Vremenska krivulja grabežljivosti soma s obzirom na selektivnost plijena (Ivleovi indikatori selektivnosti u zagradama)*

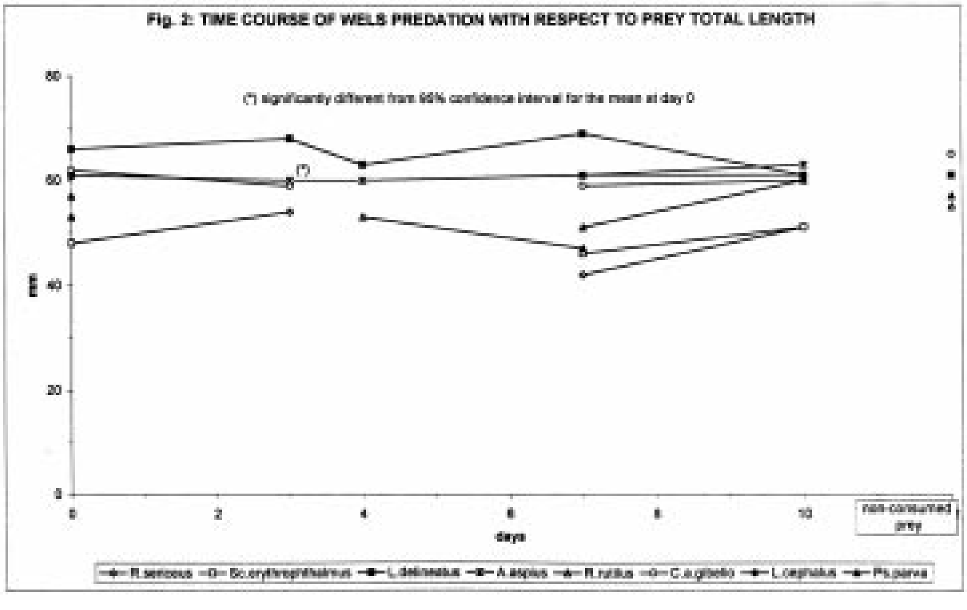


*Figure 2: Time Course of Wels Predation with Respect to Prey Total Length*
*Slika 2. Vremenska krivulja grabežljivosti soma s obzirom na totalnu dužinu plijena*

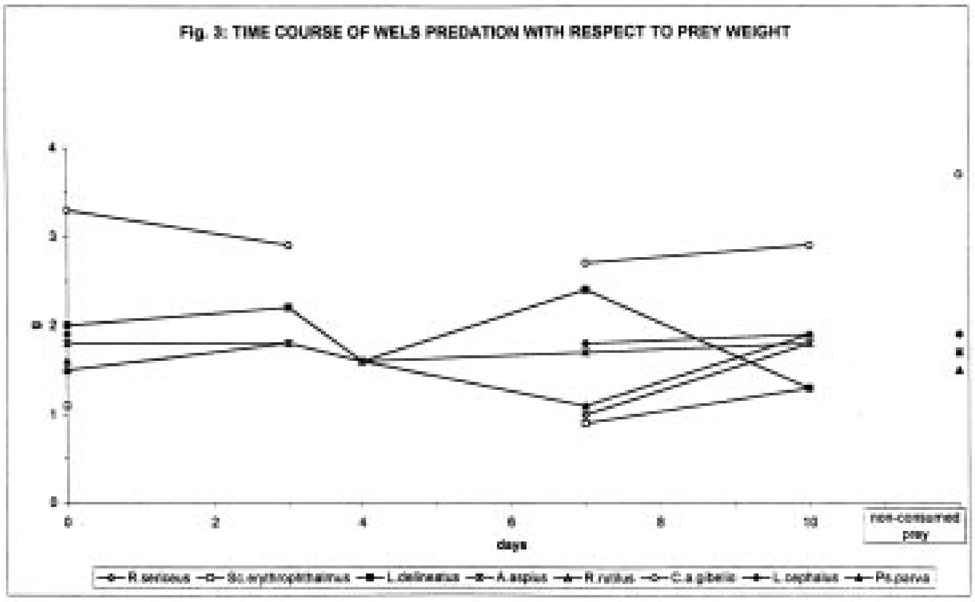


*Figure 3: Time Course of Wels Predation with Respect to Prey Weight*
*Slika 3. Vremenska krivulja grabežljivosti soma s obzirom na težinu plijena*

Specific growth rate (in %. day$^{-1}$) of experimental wels ranged from 1.25 to 3.72 (2.25±1.30), and food conversion ratio in individual fish was calculated as 2.36–2.72 (2.55±0.18).

Rudd (E = +0.18) and sunbleak (E = +0.11) were preferred prey items for African catfish, while topmouth gudgeon (E = –0.13) and Nile tilapia (E = –0.26) were avoided (Fig. 4). All prey fish (except tilapia), which remained uneaten by African catfish during the ten–day experimental period were bigger than the mean. In topmouth gudgeon, a significant decrease was registered in total length ($P<0.05$) and weight ($P<0.01$) and body height ($P<0.01$) of fish consumed on the 6th day (Figs 5–7).

The maximum mouth width in experimental African catfish was 18±1 mm and the maximum body height values found in prey fish were between 7±1 (topmouth gudgeon) to 12± mm (Nile tilapia). The mean values of specific growth rate and food conversion ratio amounted to 0.36 %. day$^{-1}$ and 4.73, respectively.

## DISCUSSION

Wels are predators of considerable commercial importance under conditions of Central European pond fish culture. Besides their commercial importance, they play a role of a police fish with the aim to control the populations of

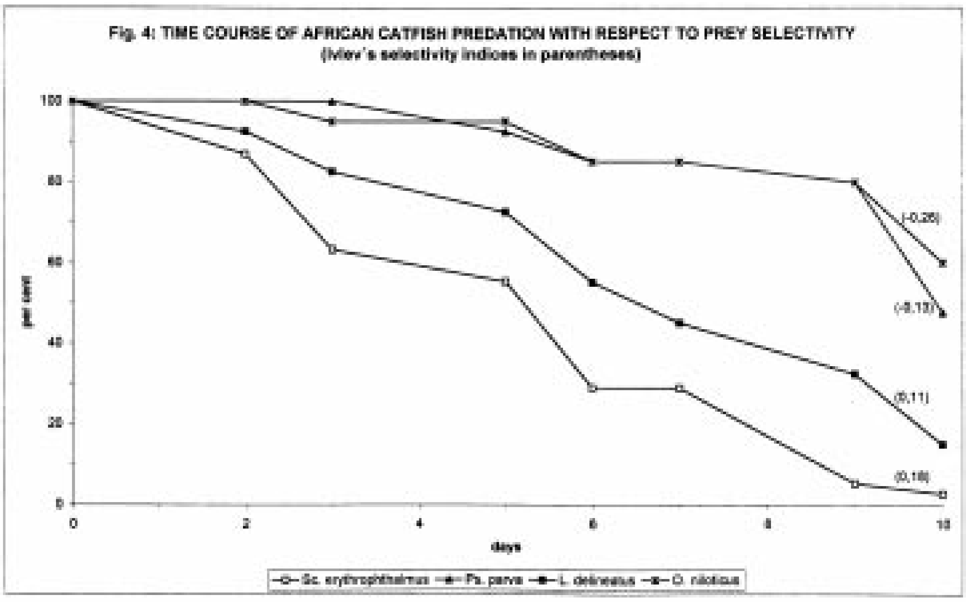


*Figure 4: Time Course of African Catfish Predation with Respect to Prey Selectivity (Ivlev's selectivity indices in parentheses)*

*Slika 4. Vremenska krivulja grabežljivosti afričkog soma s obzirom na selektivnost plijena (Ivleovi indikatori selektivnosti u zagradama)*

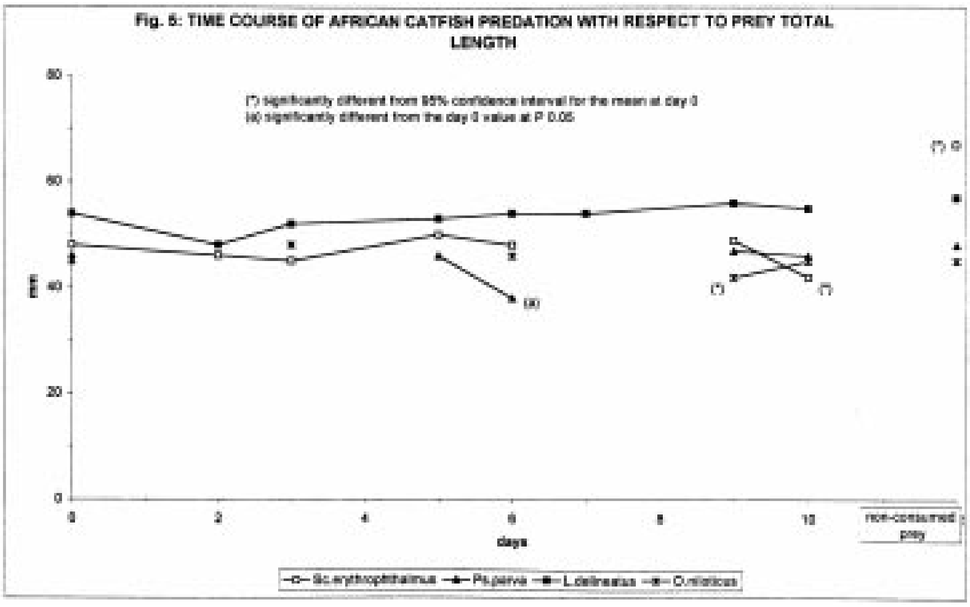


*Figure 5: Time Course of African Catfish Predation with Respect to Prey Total Length (*) significantly different from 95% confidence interval for the mean at day 0*

*Slika 5. Vremenska krivulja grabežljivosti afričkog soma s obzirom na totalnu dužinu plijena*

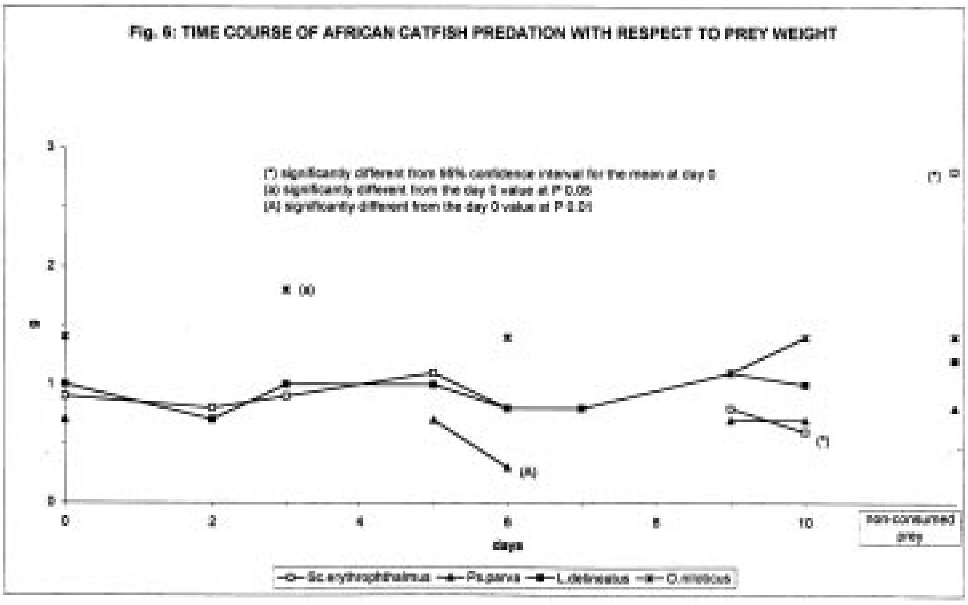


*Figure 6: Time Course of African Catfish Predation with Respect to Prey Weight*
*Slika 6. Vremenska krivulja grabežljivosti afričkog soma s obzirom na težinu plijena*

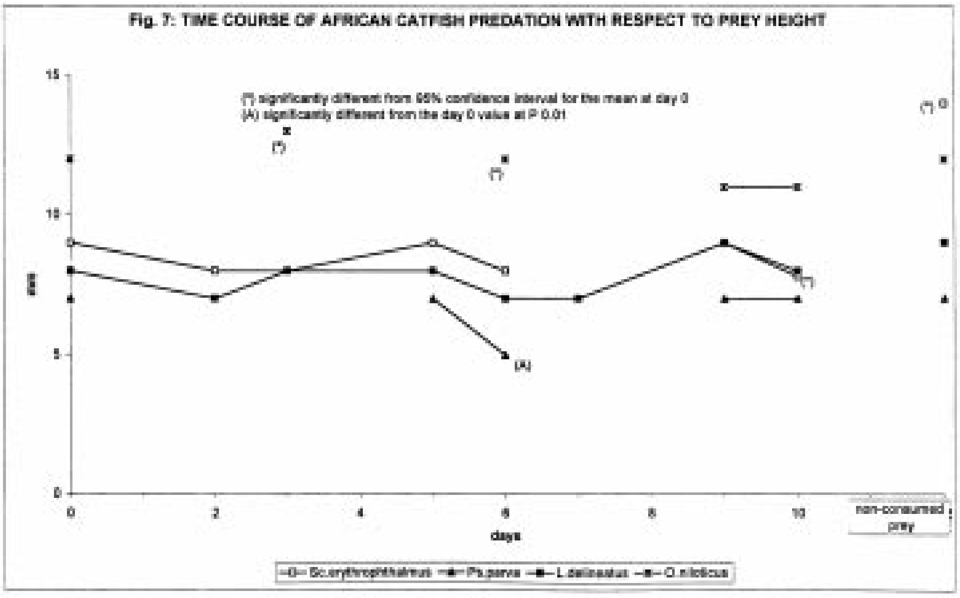


*Figure 7: Time Course of African Catfish Predation with Respect to Prey Height*
*Slika 7. Vremenska krivulja grabežljivosti afričkog soma s obzirom na visinu plijena*

small coarse fish (roach, bream, rudd, ruffe *etc.*) there. In natural waterbodies, wels are the biggest game fish highly preferred by anglers (B a r u š and O l i v a, 1995).

Prey body shape was not the deciding factor in wels prey preference. Despite rudd, sunbleak, asp, chub, topmouth gudgeon and roach do not differ considerably in their relative body height (body height/total length ratio from 0.148 to 0.187 in sunbleak and rudd respectively), their preference by wels concerned only some of them, *ie* sunbleak, rudd and asp whilst topmouth gudgeon and roach belonged among avoided prey items. On the other hand, the height/length ratio is much higher in bitterling (0.289), which was also preferred by wels.

Size spectrum of prey fish did not vary with time course during the experimental period. Regarding the predator/prey size ratio, it seems that the prey size corresponded to wels requirements because no selectivity for smaller or bigger prey fish was noticed during the experiment. The radio between predator and prey total length ranged from 0.134 in smallest fish (bitterling) and 0.283 in biggest one (topmouth gudgeon). Both these fish were consumed by wels on $7^{th}$ and $10^{th}$ experimental day respectively.

There is evident from the results of wels food preference that the non–native fish species — topmouth gudgeon and Prussian carp — belong among avoided species which were usually consumed only at the moment when the density of preferred prey fish got reduced. Surprisingly, roach which showed a high level of avoidance by wels in our experiments (–0.37) is mentioned as an important food item in almost all studies of their diet.

Some of the prey species (rudd and chub), preferred by 0+ wels in our experiments, were reported as main food fish also from the analyses of stomach contents in adult fish captured in the wild. Feeding activities of adult wels are concentrated on open water areas, usually quite far from the shore, where they attack particularly shoals of surface water fishes, like bleak (*Alburnus alburnus*), rudd and roach. However, they also often look for food fish like common bream (*Abramis brama*), roach, tench (*Tinca tinca*) and perch (*Perca fluviatilis*) in deeper parts of reservoirs (A d á m e k, 1993a). Bleak, roach, tench, barb (*Barbus barbus*) and silver bream (*Blicca bjoerkna*) were found in stomachs of wels from the Vitava river (H r b á č e k et al., 1952, H r u š k a and O l i v a, 1953). V a s i l i u and P o p e s c u (1943) examined 2,253 stomachs of wels from the Danube Delta and report bleak, roach, perch, crucian carp (*Carassius carassius*) and ruffe (*Gymnocephalus cernuus*) as main food fish. All previously mentioned, species plus chub (*Leuciscus cephalus*) are reported also by S e d l á r and Ž i t n a n (1977) from various Slovak waterbodies. H o r o s z e w i c z (1964) analyzed stomachs of 236 wels from the Vistula river. Only 8 fishes were found to be an important item of wels diet — in order of importance — bleak, gudgeon (*Gobio gobio*), ruffe, roach, dace (*Leuciseus leuciseus*), common bream and silver bream whilst the other prey fishes did not exceed the level of 2% proportion.

Experimental wels exhibited excellent growth and conversion rates. The SGR values (2.25±1.30 %. day$^{-1}$) achieved using exclusively fish as a diet are comparable with those presented by Mareš (1996) for wels yearling fed pelleted feed mixtures under controlled conditions. On the other hand, the values of specific growth rate of two–year–old wels from pond conditions (which very probably possess exclusively predatory freeding behaviour) were much lower (0.60–1.01 %. day$^{-1}$ — Mareš et al., 1996). Naturally, this is due to higher energy losses required for prey capture in a pond in comparison with prey surplus in an experimental tank. The values of FCR were quite low and very similar (2.36–2.72) in all experimental fish.

African catfish are very clumsy predators and only fish wounded by their repeated attacks are captured and eaten (Adámek and Sukop, 1995). Similarly, Clay (1979) reported his observations from the experimental poisoning of the Rhodesian Lake McIlwaine where young African catfish (which took longer to be affected by the rotenone) fed heavily on dead or dying tilapia *Sarotherodon macrochir*. Jubb (1967 ex Clay, 1979) described African catfish as an omnivorous scavenger. In our experiments, even starving catfish were not able to capture a bigger healthy fish prey and all fishes (except tilapia) which remained uneaten after the ten-day experimental period were bigger than the mean of the initial stock. Only tilapia were consumed without any size selectivity (Figs 5–7) although they were less suitable due to their highest height/length ratio. These values amounted to 0.267 in tilapia and 0.148, 0.152 and 0.188 in sunbleak, topmouth gudgeon and rudd respectively. Anyway, the width of African catfish mouth (18±1 mm) was much bigger than the maximum values of prey fish height (13 mm in several tilapia). This means that predator's mouth width is not probably a limiting factor for the ability to ingest the prey of bigger size. According to the Clay's (1979) data, the size of *Tilapia* spp. and *Sarotherodon* spp., consumed by African catfish, bears a straight–line relationship to the predator size. There is evident from the graphic presentation of his conclusions, that the size of tilapia, consumed by catfish comparable with those in our experiments (TL $\cong$ 30 cm), corresponds to 20–55 mm. This means that the total length of our tilapia prey (42–49 mm) was below the upper prey size limit of African catfish of appropriate size.

African catfish and tilapia biculture is considered as a prospective way how to control tilapia recruitment and resulting high density in growing ponds in Africa (Middendorp, 1994). However, tilapia and topmouth gudgeon were prey species which were avoided by African catfish. Both fish were consumed only sporadically (5 and 7.5% respectively) until the 5th day of the experiment and only later, when the density of other prey fish was considerably reduced, catfish started to consume them (Fig. 4). On the other hand, it must be mentioned that both preferred prey species (*ie* rudd and sunbleak) are fishes very susceptible to the external wounds which — in this case — were caused by catfish attacks.

M i d d e n d o r p (1994) considers African catfish betwen 15 and 200 g may effectively control tilapia recruitment but he admits that when feeding supplementary feeds, it was probably easier for catfish to compete with tilapia for feed than to chase tilapia recruits. He observed that tilapia ponds with catfish were free of tadpoles which possibly indicates their lower preference for the spiny tilapia fry as we have observed as well. However he suggests catfish may be successful in controlling tilapia recruitment. It is hypothesized that catfish predation is governed by a »pasive« predator–area relationship (H o p k i n s et al., 1982).

African catfish growth performance is very poor when feeding exclusively fish as a diet. The mean SGR and FCR values were quite low (0.36 and 4.73 respectively) showing that clarias loose too much energy for the capture of a prey. In one experimental fish, the growth was only negligible (0.2 g in ten days, *ie* SGR 0.01 %. day$^{-1}$) — however this fish consumed 18.5 g of prey fish during this period which corresponds to FCR 92.5. This only one value was very distinct from others and was not included among the data for calculations mentioned above.

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## ***Sažetak***

# SELEKTIVNOST PLIJENA U SOMA (*Silurus glanis*) I AFRIČKOG SOMA (*Clarias gariepinus*)

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Istraživanja su bila usmjerena na selektivnost plijena u dvije vrste grabežljivaca siluriformes — afričkog soma (*Clarius gariepinus*) i soma (*Silurus glanis*). Istraživanja su provedena u laboratorijskim uvjetima. Riba plijen (12–22% TL grabežljivaca) poslužila je jednogodišnjem afričkom somu (~220 g) i somu (~150 g) porijeklom iz intenzivnog uzgoja bez prethodnog iskustva u prehrani živim ribama. Afrički je som pokazao negativnu seketivnost (izbjegavanje) prema nilskoj tilapiji (*Oreochromis niloticus*) i amurskom čebačoku (*Pseudorasbora parva*), a crvenperka (*Scardinius erythrophthalmus*) i bjelica (*Leucaspius delineatus*) bile su preferirane (pozitivna selektivnost). Intenzitet i efikasnost proždrljivosti afričkog soma bila je posve niska, jer je njegova hranidbena strategija u osnovi zapravo na selektivnosti traženja, a ne lova. Plijen, ozlijeđen ili mrtav u tijeku neefikasnog lova, bio je bolje konzumiran za vrijeme noći. Ni jedan uspješan napad afričkog soma na zdravi plijen nije registriran. U soma je bila dokazana jaka negativna selektivnost (uklanjanje) za bodorku (*Rutilus rutilus*) i amurski čebačok (*Pseudorasbora parva*), a slabije izbjegavanje za babušku (*Carassius auratus gibelio*) i klena (*Leuciscus cephalus*). Bolen (*Aspius aspius*) nisko je preferiran, dok je visoka preferiranost pokazana za bjelicu (*Leucaspius delineatus*), crvenperku (*Scardinius erythrophthalmus*) i gavčicu (*Rhodeus sericeus*). Obje vrste soma preferirale su manji plijen za vrijeme desetodnevnog eksperimentalnog razdoblja, dok su oni koji su ostali nekonzumirani pripadali kategoriji srednjih ili većih riba.

*Ključne riječi*: *predatori, selektivnost plijena,som, afrički som, tilapija*

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