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Physiology

SPECIFIC ADAPTABILITY TO DYNAMIC EFFORT OF FISHES  
*ABRAMIS BRAMA* (L.), *RUTILUS RUTILUS* (L.), *PERCA FLUVIATILIS* L.  
*ANGUILLA ANGUILLA* (L.)

GATUNKOWA ZDOLNOŚCI RYB DO DYNAMICZNEGO WYSIŁKU FIZYCZNEGO:  
*ABRAMIS BRAMA* (L.) *RUTILUS RUTILUS* (L.), *PERCA FLUVIATILIS* L.  
*ANGUILLA ANGUILLA* (L.)

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Measured performance of fishes *Perca fluviatilis* L.,  
*Abramis brama* (L.), *Rutilus rutilus* (L.) and *Anguilla anguilla*  
(L.) proved distinct differences by species in ability to dynamic effort under determined conditions of environment.

Degree of ability to physical effort depends on specific and individual characteristics and on influence of outer environment (Sołtysiak, 1968; Soburenkov et al. 1967). Analysis of functional state during physical effort (at changes of some parameters of outer environment) prove the existence of adapting mechanisms among mammals (Eberhardt, 1969; Kozłowski et al. 1969).

Adapting reactions of organism due to environmental conditions (by adaptive regulation of neurohormonal and metabolic processes) influence the degree of ability to physical effort under determined conditions.

The cycle of present investigations performed on changes in fish organism caused by adapting processes, comprised comparative measurements to dynamic effort of four fish species remaining under determined aquarium conditions. For investigations, applied the method elaborated by authors in application of physical effort to fish (Węgrzynowicz, Kłyszewko, 1971).

METHOD

The investigations were performed in aquarium with supply line water of temperature 14°C and pH 7.6 on grown-up specimen of both sexes, of the

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following species: *Perca fluviatilis* L. - 23 pcs, *Abramis brama* (L.) - 27 pcs, *Rutilus rutilus* (L.) - 18 pcs and *Anguilla anguilla* (L.) - 29 pcs.

According to Authors method (Węgrzynowicz and Kłyszajko, 1971), a float of determined force of buoyancy was fastened to dorsal fin of fish. To overcome buoyancy force of float, the fishes were constantly making regular locomotive movements until the signs of fatigue appeared. Characteristic symptom of fatigue was the ceasation of locomotive motions and passive subduance to buoyancy force of float. Under such conditions, the fishes were swimming upto surface and remained there for certain time without any motion.

The work performed was calculated in kGm/kg of fish body weight. Following parameters were considered in tests: 1) weight of fish, 2) buoyancy force of float ( $F_w$ ), 3) ratio of float buoyancy force to weight of fish expressed in per-cent (R), 4) time of active swimming (Min.), 5) locomotive velocity of fish (m/sec.) and 6) angle between plane of water surface and longitudinal axis of fish body (ctg).

In first serie of tests were determined the treshhold values R, at which the fish (coerced to balance buoyancy force of float), continously performed regular locomotive motions during two hours without showing any signs of exhaustion.

In second serie of tests, the applied floats were of buoyancy force higher than treshhold values. Such increase of load, lead to symptoms of rapid exhaustion during predetermined time.

## RESULTS AND DISCUSSION

It is apparent from the performed tests that, treshhold values R, at which the 4 examined fishes equilibrated buoyancy force of float and within period not exceeding two hours, were performing continous locomotive motions (with speed 0.125 - 0.015 m/sec.) amount on average to: perch - 2.0%; bream - 3.7%; roach 3.9% and eel - 5.9%.

The values of work, calculated on kg of body weight for particular group of species, were adequate to treshhold values R (Tab.1).

Table 1

Results of fish performance ability at treshhold values R

Species	Number pcs	Fish weight (kg)	R (%)	Swimming time (min./sec.)	Work performed (kGm /kg of weight)
perch	11	0.080-0.270	2.0	120.0 <sup>x</sup>	50.2
bream	14	0.250-1.200	3.7	120.0	90.8
roach	17	0,060-0.513	3.9	120.0	96.6
eel	14	0.800-1.070	5.9	120.0	149.6

<sup>x</sup> discontinued after 120 min. of test.

Considering the values R, it is apparent that, out of 4 examined species, perch is the fish capable in equibalancing the float of lowest buoyancy force, while for eel the value R is highest. Bream and roach represent the intermediate groups. The values R, when increased: from 2.0 to 3.2% for perch, from 3.7 to 5.0% for bream, from 3.9 to 5.1% for roach and from 5.9 to 7.0% for eel, limited swimming time of fish to 10-11 minutes.

The results obtained indicate that, the values of work for particular species (calculated on 1 kg of body weight) under increased load are of the same order as in estimation of treshold values R, viz.: perch - lowest, eel - highest; (Tab.2).

Table 2

Results of fish performance ability under  
load increased above

Species	Number pcs	Fish weight (kg)	R (%)	Swimming time (min./sec.)	Work performed kGm/kg of weight
perch	12	0.075-0.250	3.2	10 55 <sup>x</sup>	7.3
bream	13	0.249-1.150	5.0	10 46 <sup>x</sup>	11.1
roach	11	0.060-0.420	5.1	11 10 <sup>x</sup>	11.7
eel	15	0.560-1.180	7.0	11 20 <sup>x</sup>	16.6

<sup>x</sup> period after which fish shown the signs of acute fatigue.

The tests proved that, any load above determined values R, is very vital for the examined species. High ability to effort of eel - of migrating species, is undoubtedly connected with wide adaptability to varying environment.

Lowest ability to effort of perch probably results from limited hydrostatic ability of a fish with enclosed air-bladder in comparison to open air-bladder type. It was noted during the investigations that, examined species of fish (except perch) were reducing the content of gases in air-bladder after few minutes of swimming under load of float. The reduction of pressure in air-bladder was taking place at initial phase of test only.

The minimize the effect of float buoyancy force, the fishes of open air-bladder (bream, roach, eel) were reducing the pressure in air-bladder. Perch, which could not reduce the pressure in air-bladder within short time, proved lowest ability to equibalance buoyancy force of float. In view of this, the estimation of perch ability to physical effort is relative in comparison to species of open air-bladder type.

The investigations performed proved essential differences by species in their ability to dynamic effort under determined aquarium conditions.

## CONCLUSIONS

1. Degree of ability to physical effort of fish (under uniform conditions of environment) is different for particular species.

2. Among the species examined, highest ability to dynamic effort proved eel.

3. Increased values R from 3.2 to 7.0% (respectively for particular examined species) - considerably reduce the time of ability to dynamic effort.

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#### GATUNKOWE ZDOLNOŚCI RYB DO DYNAMICZNEGO WYSIŁKU FIZYCZNEGO ABRAMIS BRAMA (L.), RUTILUS RUTILUS (L.), PERCA FLUVIATILIS L., ANGUILLA ANGUILLA (L.)

#### Streszczenie

Przeprowadzono pomiary porównawcze zdolności do dynamicznego wysiłku fizycznego czterech gatunków ryb (*Perca fluviatilis* L., *Abramis brama* (L.), *Rutilus rutilus* (L.), *Anguilla anguilla* (L.)) w warunkach akwaryjnych przy zastosowaniu metody własnej obciążenia ogólnym wysiłkiem fizycznym.

W badaniach określono progowe wartości wyporu pływaka, przy których badane ryby wykonywały nieustanne rytmiczne ruchy lokomocyjne przez okres dwóch godzin nie wykazując objawów wyczerpania. Następnie zwiększono obciążenie pracą do objawów ostrego zmęczenia.

W wyniku badań stwierdzono znaczne różnice w zakresie gatunkowych zdolności do dynamicznego wysiłku w określonych warunkach środowiska.

ВИДОВЫЕ СПОСОБНОСТИ РЫБ К ДИНАМИЧЕСКО-ФИЗИЧЕСКОМУ  
УСИЛИЮ *ABRAMIS BRAMA* (L.), *RUTILUS RUTILUS* (L.),  
*PERCA FLUVIATILIS* L., *ANGUILLA ANGUILLA* L.

Р е з ю м е

Проведены сравнительные измерения способности к динамическому физическому усилию четырёх видов рыб: *Perca fluviatilis* L., *Abramis brama* (L.) *Rutilus rutilus* (L.), *Anguilla anguilla* (L.), в аквариумных условиях с применением авторского метода нагрузки общим физическим усилием.

В исследованиях определены предельные значения плавучести поплавка, при которых исследуемые рыбы выполняли непрерывные ритмические толкательные движения в течение двух часов не проявляя признаков утомления. Затем увеличили нагрузку до наступления признаков острого утомления.

В результате исследований установлено значительные различия видовых способностях к динамическому усилию в определённых условиях среды.

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