Ph. D. Thesis

Novák J., 2007: Selected aspects of fish breeding and development, Faculty of Biological Sciences, University of South Bohemia, České Budějovice, Czech Republic, 342 pp.

Annotation

Fish breeding and development are connected to many disciplines of ichthyology. Information about ontogeny and reproductive behaviour forms an important part of knowledge of fish hobbyists, anglers, fish keepers and research workers proposing to create experimental groups (Introduction). Aspects of sexual distinction (Appendix I), methods of hormonal stimulation (Appendix V) and species determination and designation (Appendix VIII) are important mainly for hobbyists. Ontogeny studies are based both on theoretical (Rosa Lee Phenomenon – Appendix II) and practical (species growth strategy – Appendix III, summarization of the growth data estimating ecological characters – Appendix VI, annulus creation in tropical conditions – Appendix IV) standpoints. Characters available in forming of evolutionary trees can be found in ontogeny (Appendix VII) even if they are based mostly on nuclear acids (Appendix IX). Evocation of deprivation states in fish indicated that fish are not simple creatures from the psychological point of view and merit more interest not only due to the fact that their base is connected to historical grounds of Vertebrates.

This thesis is based on the following papers from which the Appendix X has been used for summary and presentation:

Novák J.: Rozmnožování akvarijních ryb. *Book manuscript acceptedy by the Publishing house Grada*…….Introduction

Hanel L., Novák J., 1982: Further note on the butterflyfish (Pantodon buchholzi, Pisces, Pantodontidae). *Věst. čs. Společ. zool., 46: 81-84* ……..……Appendix I

Novák J.: 1983: Notes on the phenolenon of Rosa Lee illustrated on the rudd growth (Scardinius erythrophthalmus, Pisces, Cyprinidae). *Věst. čs. Společ. zool., 47: 169-174*……..…….……Appendix II

Novák J., 1983: Evaluation of the growth strategy of the rudd (Scardinius erythrophthalmus; Pisces; Cyprinidae). *Věst čs. Společ. zool.: 175-183*…….……Appendix III

Johal. M.S., Novák J., Oliva O., 1984: Notes on the growth of the common carp (Cyprinus carpio) in Nothern India and in Central Europe. *Věst. čs. Společ. zool., 48: 24-38*…….Appendix IV

Novák J., 2003: Hormonální stimulace v odchovech ozdobných ryb. *Bulletin VÚRH Vodňany, ½: 82-85*……...…..…Appendix V

Jůza T., Novák J., 2003: Růst ryb v České republice, *Bulletin Lampetra, V: 112-145*……..….Appendix VI

Říčan O., Musilová Z, Muška M., Novák J., 2005: Development of coloration patterns in

Social Deprivation in Fishes Illustrated on *Tropheus* Mouthbrooders (Pisces, Cichlidae)

Introduction

Psychic deprivation is caused by insufficient satisfaction of basic needs in the early phases of ontogeny and can be qualified as a substantial limitation of sensory, social and emotional stimulation resulting in an atypical development of behaviour patterns and serious problems in communication. Deprivation depends on quality of parental care. In humans it is caused by negative, often traumatizing experience during childhood (Njiokiktjien, 1988) and probably in the prenatal-phase as well (Kubicka et al., 1995), and manifests itself as dysphoria, impaired socialization and motoric atypia - attenuated and excited states (Weinberg et al., 1973) and depression (Kolvin et al., 1984; Weissmann et al., 1987). Human maternal care at the very onset of life has a direct influence upon the postnatal development of the brain centres responsible for the regulation of distress (amygdale) - Liu et al. (1997). Conditions leading to deprivation, sensitive periods and ways of learning are still under discussion in apes and birds (Harlow & Harlow, 1962; Immelmann, 1972).
Neuroendocrinological mechanisms regulating the fish parental care are connected with both extrinsic and intrinsic factors. Main stimulants were found in the perceptive discrimination (visual – Barlow, 1974; Greenberg, 1963; Hay, 1978; Russock & Schein, 1977 and olfactory – Barnett, 1986; Crapon de Caprona, 1982; Myrberg, 1975). They include behavioural interactions, especially between fry and parents and those connected to social status (Vives, 1988) and complex of social experience or social isolation (Coss & Globus, 1979; Heiligenberg, 1963; Meyer, 1986). The consequences of insufficient, species-strange or ontogenetically inadequate stimulations are demonstrated by atypical schoaling behaviour (Shaw, 1970), modified aggressive-pattern, sexual behaviour (Seitz, 1940, 1941), and parental care (Riccobene, 1999; Schneidewind, 1996; Van der Elst, 1999).
In fishes, it is supposed that learning process also modifies the innate behavioural mechanisms, but causes and consequences of deprivation are not determined yet. Examples of imprinting in fishes were published by Kop & Heuts (1973) and Sjölander & Fernö (1973), an

overview is given by Noakes (1991). Other authors (Crawford & Balon, 1996; Balon, 1991) deal with the close relation of parents and fry in fishes with parental care: Cleaning and transferring of young by parents become more frequent in the phylogeny and embryos or eggs are retained in the pharyngeal cavity of the parent.
The female takes eggs into the mouth in many cichlid species (Cichlidae). The *Tropheus* species belong to the most advanced cichlid mouthbrooders. The fry in mother‘s mouth feeds on the food, consumed by the female in *Tropheus*. The eggs, hatched free embryos and juveniles are carried in the female´s mouth for together 30-45 days, before they are released as fully free-swimming fry. This highly effective care for eggs and embryos results in extremely low fecundity. *Tropheus* species are laying only about ten eggs per spawning on average. Number of spawning varies mostly from one to six per one year (Brichard, 1992; Schneidewind, 1996).
The most comprehensive mouthbrooding care vocabulary was published by Barlow (2000). *Tropheus* species kept in aquaria belong to promptocavus (regarding timing) and unicavus – matricavus – iterocavus (after male and female investment) mouthbrooding type. It means that non-adhesive eggs, are picked up by one parent (the mother only in *Tropheus*), which continues to accept young back into the mouth after they have become free-swimming.
From the hobbyist´s point of view, *Tropheus* mouthbrooders belong to the so-called problematic fish species. These fish form a society with well-expressed hierarchy from alpha to omega specimen in aquaria. Individuals are extremely stressed by manipulation and diseases-attacks and often die in consequence of shock. The data from fish keepers and breeders have been summarized by Schneidewind (1996), social behaviour was studied by Wickler (1969). *Tropheus* species should be kept in societies formed by 20 – 30 individuals in a density one specimen per 10 – 15 litres of water. At least about ten males should be kept in one society. Usually one dominant male only defends the territory, while other individuals serve as absorbers of powerful specimens aggressivity. Higher density or higher number of individuals leads to the stress and dying, lower density causes mutual killing of specimens. The fish schoal is a delicate society. Newly added specimens (including individuals returned into the society after separation) are often killed. According to extensive empirical experiences of fish keepers and hobbyists, keeping of a thirty-specimens schoal (sex ratio 1:1) leads to the optimal surviving and long-termed populations (Schneidewind, 1996). The pairs spawn quickly, usually in the open water near the stone slope and the female takes egg into her mouth before it strikes the ground. In one spawning act only one egg is laid. Usually the spawning consists of several acts and about two to seventeen eggs are laid in all. The female with the full pharyngeal cavity lives in a society up to the time of fry releasing. The female never accepts lost eggs or eggs forcibly taken from her mouth. Mothers learn the eggs incubation successively. Young females at the age of one or two years often lose or eat some or all eggs.
In 1980´s, Czech ornamental fish keepers had developed several kinds of incubators (so-called artificial mouths), where eggs of Cichlid mouthbrooders at the eye spot stage, forcibly taken from the mouth of the mother, were put because of easier handling, control and economy of fish keeping and raising. Incubators are mostly made from plastic cups, wine glasses or laboratory cups. Observation of keepers and breeders have led to the ascertainment that the eggs and fry, bred in the „artificial mouth“, grow into individuals with a higher degree of aggressivity which do not multiply easily. Incubator-born females often are bad mothers, eating or loosing offspring much frequently in comparison with females, grown in conditions corresponding to the species life history. The term "post-natal depression" has been used for mouthbrooders raised in incubators (Van der Elst, 1999).

Results and discussion

In the experiments, following mouthbrooders of the genus *Tropheus* were used - classification of species and colour phases see Brichard (1992), Schneidewind (1996) and Sturmbauer (2003): *T*. sp. „Caramba“, *T*. sp. „Bemba“, *T. duboisi* „Maswa“, *T. brichardi* „Kipili“, *T. polli* „Bulu Point“.
Tested communities (experimental groups) were formed by the schoals of thirty specimens of one species (colour phase) with the sex ratio of 1:1 per one tank. Deprived (reared in the incubator, designated as D) and “normally” (reared by the mother, designated as N) behaving specimens were kept separately in strictly controlled laboratory conditions.
All experimental groups both N- and D-specimens were observed with the aim to establish the number of offspring reared by natural way. Each group was observed for two years, i.e. from the end of the second year till the end of the fourth year of life.
Significant differences among “normal” specimens of *T*. sp. “Caramba”, both wild and aquaria-born, of different tanks and generations were not found. In the “normal” schoal about 50 - 60 spawnings occurred through two years period while the frequency of spawnings is a half in the deprived one. Each experimental group included 15 females, it means that one ”normal” female spawned twice a year on average, the deprived one only once a year. The “normal” female produces up to 17 eggs in one spawning (about eight on average) and releases about six young on average after incubation. The deprived female produces the same amount of eggs in one spawning on average (eight to nine) though she releases maximally four but mostly no young. The N-females eat or loose only two embryos during the incubation on average, but D-females up to nine embryos, also the numbers of the offspring decline dramatically in D-females. D-females rear notably and significantly fewer fry than N-females. However, the fecundity of N- and D-females practically does not vary significantly. Clutch sizes vary mostly as few as four in young (one year old) females and sixteen in two to five years old ones. The survival rates of eggs and embryos during natural incubation in mother´s mouth and during incubation in the incubator also do not differ significantly. Further summarized observations intended to confirm the influence of eggs origin (of the D- or the N-mother) on the fitness of the embryos almost did not support such option.
Significant differences between summarized N- and D-groups (all species and colour phases) support that deprived groups of the genus *Tropheus* produce less young, than “normal” communities.
The results also confirm the fact of importance for ornamental fishbreeders, both professional and amateur, that artificially reared cichlid mouthbrooders go to spawn less frequently. This can be caused by higher aggressivity of deprived individuals (Heiligenberg & Kramer, 1972; Schneidewind, 1996). There were two dominant males in each tank with N-specimens every time, in tanks with D-specimens the whole territory was occupied by a single male only.
Deprivation has been defined as a psychosocial phenomenon in humans and was studied comparing groups of individuals growing under solicitude family conditions, which spent their infancy or childhood in non-complete families or under institute care. From these reasons, the origin of many individuals was not fully known. Also it was not possible to compare significantly extremely rare cases of development of brothers and sisters groups growing under different conditions (compare Kolvin et al., 1984; Njiokiktjien, 1988; Weitzmann et al., 1987). Nevertheless the existence of deprivation is respected in psychiatry, clinical psychology, diagnosis and therapy.
Tropheus species have been used for experiments because they represent a group of fishes with most advanced parental care (Balon, 1991) and complicated social behaviour

(Schneidewind, 1996). Like in human psychology, with regard to the character of *Tropheus* life history (see Introduction), it was not possible to organize experiments quite exactly. E.g. valid and significant comparing behaviour of the same-age-offspring of one mother reared under "normal" and depriving conditions, was not possible due to the low fecundity of *Tropheus* species. Moreover, it is not possible to remove only a part of eggs from the mother. The female eat or loose all remaining eggs during a short time after this brutal manipulation. Also it was not possible to observe experimental groups for a longer time. *Tropheus* shows a higher mortality rate, caused by aggressivity, stress and diseases (Schneidewind, 1996). It has been possible to guarantee only the correct determination of the species (colour phase), the same origin and the same age of individuals, sex ratio and number of specimens for defined two years (nevertheless many experiments had to be cancelled in consequence of specimens death) and strictly controlled laboratory conditions.
Four main questions were putted to ascertain if the deprivation status could be evoked in mouthbrooding *Tropheus* species:

- Does the rearing facility of females´ generations vary during aquaria breeding?
- How differs the fecundity of "normal" and deprived females?
- Are there differences among different species in the number of reared offspring?
- Is the reproductive success of "normal" and deprived fish groups different?

Considering the first question, it is possible to confirm, using observations of four groups of *Tropheus* sp, "Caramba", that the reproductive success of "normal" females both natural and aquaria generation does not differ. The influence of the tank upon the reproductive success of the fish group can be also excluded. The fecundity of "normal" and deprived females is almost the same and the difference in the number of reared fry between two phylogenetically distant *Tropheus* species (*T.* sp. "Caramba" and *T. duboisi*) is not significant. Significant differences between reproduction success of "normal" and deprived fish groups have been confirmed both in *T.* sp. "Caramba" and in the complex of all different species (colour phases) observed. Simultaneously, it has been confirmed that there is no significant difference between surviving of fry in the mother´s mouth and in the incubator. Incubator-reared individuals can be also characterized as "normal" from the physiological point of view. The higher aggressivity of incubator-reared fish in contrary to those grew under the conditions of mother´s care was not tested, but it makes serious problems in experiments. Many deprived groups have crumbled due to tragic mutual attacks among individuals. With respect to the fact that deprived groups of *Tropheus* produce less offspring, another question is arising: Is the ill-success of deprived fish in reproduction caused by the simple inability of females to care for young or by their stress from the negative packed milieu? Experiments with the isolation of carrying females, both "normal" and deprived are proceeding currently and will be published later.
The contribution is not authorized to make general conclusions but it would like to notice the fact of social or psychical deprivation in fishes respectively and to provoke more interest. In five colour phases of mouthbrooding cichlids of four species of the genus *Tropheus,* it was proved only that a state of social deprivation maybe evoked. These fish are not simple animals but complicated creatures with psychosocial development depending on the maternal care. The data are not many, but they are sufficient to show that the costs-benefits theory of parental care (Gross & Sargent, 1985) should be widened. Results of experiments demonstrate that an important part of benefits of parental care also consists of the guarantee of psychosocial learning of the offspring in mouthbrooding fishes.
The fact that about 6,000 fish species (about 20 % known) of at least 87 families show parental care (Blumer, 1982; Nelson, 2004) indicates a tree of evolutionary stories. The paternal care (the male cares) is suggested to be evolutionary basal, and it is known in most fish families with parental care (e.g. lungfishes - Dipnoi, some characoids - Characiformes,

sunfishes - Centrarchidae, gouramies - Belontiidae etc.). More derived modes (biparental and maternal) are restricted to cichlids (Cichlidae) - Peters & Berns (1982). Mouthbrooding, being suggested the most derived path of parental care, has evolved independently 10-14 different times in cichlids (Goodwin et al., 1998), and it is known in other fish groups (e.g. in phylogenetically old arowanas - Osteoglossidae or sea catfishes - Ariidae, as well as in "modern" taxa like cardinalfishes – Apogonidae and some fighting fishes - *Betta* as well) - Mc Lennan (1994), Nelson (1994), Sterba (1987). But information if depriving conditions may be involved in other groups of fishes with the parental care is still lacking. However successful induction of the deprivation state in mouthbrooding cichlids indicates that parental care forms an important part of behaviour and evolution of all main groups of Vertebrates.

Conclusions and Perspectives

Five colour phases of populations presently not assigned to species and identified only informally by their presumed distributional limits of mouthbrooding cichlids (family Cichlidae) of the genus *Tropheus* were tested to see whether a state of social deprivation can be triggered. The influence of parental care upon psychosocial development of the fry was confirmed experimentally. An important part of development of the behaviour patterns is the process of offspring learning during the parent-contact spell. The results confirm a fact of importance to ornamental fish breeders that artificially reared cichlid mouthbrooders reproduce less readily. Artificial hatching devices are harmful to the offspring of mouthbrooding fish species and their use can be deemed acceptable only in certain cases of species conservation or experimental endeavors.

While trying to find out what might be lacking mouthbrooders put as early embryos into the artificial hatchery, the chemical cue of the mouth may be also considered to affect the maturing of the embryos' nervous system (Barnett, 1986; Crapon de Caprona, 1982; Myrberg, 1975). Epigenetical aspects of "mother´ s love" influence upon receptors controlling stress hormones and promotors of glucocorticoid receptors in hippocampus and then upon development of behavioural formulas were studied in laboratory rats (Weaver et al., 2004). With regard to the facts stated above, a complex of tactile, olfactory and visual communication may be discussed between the embryos and mother´ s mouth and also in the early stage of free-swimming fry learning (Crapon de Caprona, 1982; Schneidewind, 1996; Van der Elst, 1999; Velasco, 1996). Mutual kinesthetical perception among the embryos cannot be also excluded.

Causes and consequences of social deprivation in mouthbrooding cichlids are worth of further study. Remarkably little has been published about post pharyngeal care duration (the time between first release of fry and last guarding of young) in *Tropheus*. Species of this genus are semelcavus in the nature, i.e. once the fry is released it is never taken back into the mouth (Barlow, 2000; Brichard, 1992). According to present observations, *Tropheus* species show the iterocavus mode (Barlow, l.c.) of mouthbrooding in aquaria. After the fry is released it remains with the mother and re-enters the mother´ s mouth to escape danger for about three to five days. At present, there is no hypothesis clarifying the possibility of the re-socialization of deprived individuals. Experience of Czech hobbyists, whose have an incredible knowledge of the intricacies of ornamental fish farming, indicates that behaviour of individuals taken from mothers´ mouth at the stage of developed embryo is on a "half-way between deprivation and a normal state" (Stetina, pers. com.). Nothing is known about the deprivation in mouthbrooders with the shorter time of mouth care. *Pseudocrenilabrus multicolor* is often used as model in

behavioural studies (Mrowka, 1986) and could be exploited for further and from the experimentator´s point of view not so complicated experiments.

References

Balon, E.K. (1991). Probable evolution of the coelacanth´s reproductive style, lecitotrophy and orally feeding embryos in cichlid fishes and in *Latimeria chalumnae*. - Environmental Biology of Fishes 32: 249-265.

Barlow, G.W. (1974). Contrasts in social behaviour between Central American fishes and coral-reef surgeon fishes. - Am. Zool. 14: 9-34.

Barlow, G.W. (2000). Guest Commentary: How to Observe and report Mouthbrooding in Cichlid Fishes. - Cichlid News 6: 24-31.

Barnett, C. (1986). Rearing conditions affect chemosensory preferences in young cichlid fish. – Ethology 72: 227-235.

Blumer, L.S. (1982). A bibliography and categorization of bony fishes exhibiting parental care. - Zool. J. Linnean Soc., London 76: 1-22.

Brichard, P. (1992). Das grosse Buch der Tanganjikacichliden. bede Verlag, Kollnburg, 543 pp.

Coss, R. G. & Globus, A. (1979). Social experience affects the development of dendritic spines and branches on tectal interneurons in the jewel fish. - Develop. Psychobiol. 12: 347-358.

Crapon de Caprona, M.-D. (1982). The Influence of Early Experience on Preferences for Optical and Chemical Cues Produced by both Sexes in the Cichlid Fish *Haplochromis burtoni* (*Astatotilapia burtoni*, Greenwood 1979). - Z. Tierpsychol. 58: 329-361.

Crawford, S.S., Balon, E.K. (1996). Cause and Effect of Parental Care in Fishes. An Epigenetic Perspective. - Advances in the Study of Behaviour, Academic Press 25: 53-107.

Goodwin, N.B., Balshine-Earn, S. & Reynolds, J.D. (1998). Evolutionary transitions in parental care in cichlid fish. - Proc. Roy. Soc. London (B) 265: 2265-2272.

Greenberg, B. (1963). Parental Behaviour and Imprinting in Cichlid Fishes. - Behaviour 21: 127-144.

Gross, M.R. & Sargent, R.C. (1985). The Evolution of Male and Female Parental Care in Fishes. - Amer. Zool. 25: 807-822.

Harlow, H.F. & Harlow, M.K. (1962). Social Deprivation in Monkeys. - Scient. American 207: 137-146.

Hay, T.F. (1978). Filial imprinting in the convict cichlid fish *Cichlasoma nigrofasciatum*. – Behaviour 65: 138-160.

Heiligenberg, W. (1963). Ursachen für das Auftreten von Instinktbewegungen bei einem Fische (*Pelmatochromis subocellatus kribensis*). - Z. vergl. Physiol. 17: 339-380.

Immelmann, K. (1972). Sexual and other long-term aspects of imprinting in birds and other species. - Adv. Study Behav. 4: 147-174.

Kolvin, P., Berney, T.P. & Bhate S. (1984). Classification and diagnosis of depression in school phobia. - British Journal of Psychiatry 145: 347-357.

Kop, P.A.M. & Heuts, B. (1973). An experiment on sibling imprinting in the jewel fish *Hemichromis bimaculatus* (Gill, 1862, Cichlidae). - Rev. Comp. Animal. 7: 63-76.

Kubicka, L., Matejcek, Z., David, H.P., Dytrych, Z., Miller, W.R. & Roth, Z. (1995). Children from Unwanted Pregnancies in Prague, Czech Republic Revisited at Age Thirty. - Acta Psychiat. Scand. 91: 361-369.

Liu, D., Diorio, J., Tannenbaum, B., Caldji, C., Franci, D., Freedman, A., Sharma, S., Pearson, D., Plotsky, P.M. & Meaney, M.J. (1997). Maternal care hippocampal gluccocorticoid receptors, and hypothalamic - pituitary - adrenal responses to stress. – Science 277: 1659-1662.

Mc Lennan, D.A. (1994): A phylogenetic approach to the evolution of fish behaviour. – Reviews in Fish Biology and Fisheries 4: 430-460.

Meyer, A. (1986). Changes in behaviour with increasing experience with a novel prey in fry of the Central American Cichlid, Cichlasoma managuense (Teleostei: Cichlidae). – Behaviour 98: 145-167.

Mrowka W., 1986: Satiation Restores Brood care Motivation in the Female Mouthbrooder Pseudocrenilabrus multicolor (Cichlidae). – Physiology & Behavior, 38: 153-156.

Myrberg, A.A., (1975). The role of of chemical and visual stimuli in the preferential discrimination of young by the cichlid fish *Cichlasoma nigrofasciatum* (Günther). - Z. Tierpsychol. 37: 274-297.

Nelson, J.S. (1994): Fishes of the World. John Wiley & Sons, New York.Chichester.Brisbane.Toronto.Singapore, 600 pp.

Njiokiktjien, C. (1988). Pediatric Behavioural Neurology, Vol 1, Clinical principles. - Suyi Publicaties Amsterdam, 395 pp.

Noakes, D.L.G. (1991). Ontogeny of behaviour in cichlids. - In: Cichlid Fishes Behaviour, ecology and evolution (Keenleyside, M.H.A., ed.). Chapmann & Hall, London.New York.Tokyo.Melbourne.Madras: 209-224.

Oppenheimer, J.R. (1970). Mouthbreeding in Fishes. - Anim. Behav. 18: 493-503.

Peters, H.M., Berns, S. (1982). Die Maulbrutpflege der Cichliden. - Z. zool. Syst. Evolut.-forsch. 20: 18-52.

Riccobene, J. (1999). Guest commentary: Are your cichlids depressed? - Cichlid news 8, 1: 37.

Russock H.I., Schein M.W., 1977: Effects of age and experience on the filial behaviour of Tilapia mossambica fry (Pisces: Cichlidae). - Behaviour 61: 276-303.

Schneidewind, F. (1996). Das grosse Buch der Tropheus-Cichliden. bede Verlag, Ruhmannsfelden, 103 pp.

Shaw, E. (1970). Schooling in fishes: Critique and review. - In: Development and Evolution of Behaviour (Aronson, L.R., Tobach, E., Lehrman, D.S. & Rosenblatt, D.S., eds.). Freeman, San Francisco. 452.

Seitz, A. (1940). Die Paarbildung bei einigen Cichliden I. - Z. Tierpsychol. 4: 40-84.

Seitz, A. (1941). Die Paarbildung bei einigen Cichliden II. - Z. Tierpsychol. 5: 74-100.

Sjölander, S. & Fernö, A. (1973). Sexual imprinting on another species in a cichlid fish *Haplochromis burtoni*. - Rev. Comp. Anim. Behav. 7: 77-81.

Sterba, G. (1987). Süsswasserfische der Welt. Urania-Verlag, Leipzig.Jena.Berlin, 915 pp.

Sturmbauer, C. (2003). The evolution of the genus *Tropheus.* - In: African Cichlids II Tanganyika I *Tropheus* (Schupke, P.). Verlag A.C.S., Rodgau: 26-29.

Van der Elst, W. (1999). Guest commentary: A mouthful of SSS. - Cichlid news 8, 2: 22-26.

Velasco, F.T. (1996). Coping with Aggression in the Cichlid Aquarium. - Tropical Fish Hobbyist 44, 10: 78-88.

Vives, S.P. (1988): Parent choice by larval convict cichlids, *Cichlasoma nigrofasciatum* (Cichlidae, Pisces). - Anim. behav. 36: 11-19.

Weaver, I.C., Cervoni, N., Champagne, F.A., D´Alesio, A.C., Sharma, S., Seckl, J.R., Dymov, S., Szyf, M., Meaney, M.J. (2004). Epigenetic programming by maternal behaviour. – Nat. Neurosci. 7 (8): 791-792.

Weinberg, W.A., Rutnau, J. & Sullivan, L. (1973). Depression in children referred to an educational diagnostic centre. Diagnosis and treatment. - Journal of Pediatrics 83: 1065-1072.

Weissmann, M.M., Gammon, G.D. & John K. (1987). Children of depressed parents: Increase psychopathology and early onset of major depression. - Archives of General Psychiatry 44: 847-853.

Wickler, W. (1969). Zur Soziologie des Brabantbuntbarsches, *Tropheus moorei.* - Zeitschrift f. Tierpsychologie 26: 967-987.

Věst. čs. Společ. zool., **46**: 81—84, 1982

Department of Systematic Zoology, Charles University

FURTHER NOTE ON THE BUTTERFLYFISH (PANTODON BUCHHOLZI, PISCES, PANTODONTIDAE)

Lubomír HANEL & Jindřich NOVÁK

Received October 6, 1980

A b s t r a c t. The butterflyfish (*Pantodon buchholzi* Peters, 1876) from Nigeria was examined using 6 meristic and 10 plastic characters. Obtained values were compared with published data. Special attention was devoted to the problem of sexual dimorphism not only in Nigeria, but also in further specimens from aquaria.

Věst. čs. Společ. zool., **47**: 169—174, 1983
ISSN 0042—6595

Department of Systematic Zoology, Charles University, Praha

NOTES ON THE PHENOMENON OF ROSA LEE ILLUSTRATED ON THE RUDD GROWTH (SCARDINIUS ERYTHROPHTHALMUS, PISCES, CYPRINIDAE)

Jindřich NOVÁK

Received April 28, 1981

A b s t r a c t. The Phenomenon of Rosa Lee was studied using length-growth tables of the Phenomenon of Rosa, Lee was made using tables of the growth of the rudd Klíčava valley reservoir in Central Bohemia (Czechoslovakia) in the years 1962—1979. Methods of studying, causes and consequences of this phenomenon are discussed. The selective mortality is probably responsible for the existence of the Lee's Phenosaudied for several years allows the study of Lee's Phenomenon for each computed values computation and growth comparison.

Věst. čs. Společ. zool., **47**: 175—183, 1983
ISSN 0042—6595

Department of Systematic Zoology, Charles University, Praha

EVALUATION OF THE GROWTH STRATEGY OF THE RUDD (SCARDINIUS ERYTHROPHTHALMUS; PISCES: CYPRINIDAE)

Jindřich NOVÁK

Received August 31, 1981

A b s t r a c t. The growth of the rudd in selected types of water bodies was compared. The slowest growth tempo was ascertained in central European backwaters, the fastest in rivers and lakes of the south part of the USSR. Some factors affecting the possibilities of comparison of the fish growth in different localities or regions are discussed.

Věst. čs. Společ. zool., **48**: 24—38, 1984
ISSN 0042—6595

Department of Zoology, Punjab University, India
Department of Systematic Zoology, Charles University, Prague

NOTES ON THE GROWTH OF THE COMMON CARP (CYPRINUS CARPIO) IN NORTHERN INDIA AND IN CENTRAL EUROPE

Mohinder Singh JOHAL, Jindřich NOVÁK and Ota OLIVA

Received June 28, 1982

A b s t r a c t: The growth of 87 specimens of the common carp, *Cyprinus carpio* Linnaeus, 1758 from four localities of northern India viz., Gobindsagar Himachal Pradesh, Nangal Lake, Punjab Sukhna Lake, Chandigarh and Ghagger river, Rang Mahal Rajasthan based on the scale structure has been compared with that of the selected European and Asian localities. The growth of carp in the northern Indian waters with temperature ranging from 7 °C to 33 °C was found to be very fast, especially in the first two years of life.

HORMONÁLNÍ STIMULACE V ODCHOVECH OZDOBNÝCH RYB

HORMONAL STIMULATION IN BREEDING OF ORNAMENTAL FISH

J. NOVÁK

Abstract

Keepers and fish farmers have often tried to induce breeding by hormones in commercially attractive ornamental fishes. A review of experiments in successful breeding tropical aquarium fish with hormones is given.

Bulletin Lampetra V: 112-145
ZO ČSOP Vlašim, 2003

RŮST RYB V ČESKÉ REPUBLICE

Fish growth in the Czech Republic

Tomáš JŮZA, Jindřich NOVÁK

Biologická fakulta Jihočeské University, České Budějovice Branišovská 31, 370 05 České Budějovice, Česká republika, e-mail: Tomas.Juza@seznam.cz; at.jindra@volny.cz

Keywords: fishes, length growth, legal-allowed catch-size, Czech Republic

SUMMARY

Fish growth in the Czech Republic

A summary-attempt of fish growth in the Czech Republic is presented using published data and unpublished informations of many authors. Length-growth data of 23 fish species from the years 1950 – 2000 being exposed (*Abramis brama* - Bream, *Alburnus alburnus* - Bleak, *Aspius aspius* - Asp, *Barbus barbus* - Barbel, *Blicca bjoerkna* - White Bream, *Carassius carassius* - Crucian Carp, *Coregonus lavaretus maraena* - Common Whitefish, *Ctenopharyngodon idellus* - Grass Carp, *Cyprinus carpio* - Carp, *Esox lucius* - Pike, *Gobio gobio* - Gudgeon, *Gymnocephalus cernuus* - Ruffe, *Leuciscus cephalus* - Chub, *Leuciscus leuciscus* - Dace, *Perca fluviatilis* - Perch, *Rutilus rutilus* - Roach, *Salmo trutta* - Trout, *Scardinius erythrophthalmus* - Rudd, *Silurus glanis* - Wels, *Stizostedion lucioperca* - Pikeperch, *Thymallus thymallus* - Grayling, *Tinca tinca* - Tench, *Vimba vimba* - Vimba). Six types of localities (brooks, rivers, valley water reservoirs, small water bodies of the inundation regions of rivers, fishponds and flooded mining areas) have been specified. Followed statistical indexes have been used (abbrevitations in Czech used in Tables 1 – 23 are in bracketts) for evaluation of the data-set consistence: average (pr.), median (m.), standard deviation (sm. od.), coefficient of variance (var. k. %), 95 % confidence interval (konf. int.) and min-max (min-max) values. Regarding the growth data, significant differences were found in most types of localities and most fish species using Two–Way Analysis of Variance. Legal-allowed catch-sizes of angled fish species in the Czech Republic being discussed.

Folia zoologica, vol. 54 (2005), Monograph 1, 46 pp.

Oldřich Říčan[1], Zuzana Musilová[2], Milan Muška1 and Jindřich Novák[1]

[1] *Department of Zoology, University of South Bohemia, Branišovská 31, 370 05 České Budějovice, Czech Republic; e-mail: oldrichr@yahoo.com*

[2] *Department of Zoology, Faculty of Sciences, Charles University, Viničná 7, CZ-128 44 Praha 2, Czech Republic; e-mail: zuzka.musil@email.cz*

ŘÍČAN O., MUSILOVÁ Z., MUŠKA M. & NOVÁK J. 2005: Development of coloration patterns in Neotropical cichlids (Teleostei: Cichlidae: Cichlasomatinae). *Folia Zool. 54 (Monogr. 1): 46 pp.*

Abstract

We present a developmental study focusing on the development of coloration patterns in a subgroup of Neotropical cichlids, the subfamily Cichlasomatinae. Based on the presented coloration ontogenetic series of 40 species we show that developmental information is a necessary prerequisite for any serious attempts in understanding adult coloration patterns. The center of our contribution is a detailed description of coloration ontogenies in a selected sample of cichlids and their discussion in a much wider taxonomical sampling. The pigmentation pattern ontogeny is specifically used to determine developmental homology of individual vertical bars. Early ontogeny is documented from the onset of the free-swimming period, which is also used as a point of reference for possible heterochronic shifts as presented here. A single universal process is responsible for the transformation of longitudinal melanophore migration lines into vertical bars, which form the dominant elements of adult coloration of most cichlids. Adult vertical bars vary interspecificaly in their numbers, whereas their ontogenetic precursors are stable in number across all surveyed species. The diversity of adult barring patterns is produced by differential fusions of a conserved number of developing bars, from which the different taxon specific numbers of adult bars develop. The possibility of determining individual homology of cichlid vertical bars is a prerequisite for the use of coloration pattern characters in cichlid phylogenetic studies. Several ontogenetic characters are formulated as synapomorphic at various systematic levels.

Cybium, 30 (1): 92

Formosania: A replacement name for *Crossostoma* Sauvage, 1878 (Teleostei), a junior homonym of *Crossostoma* Morris & Lycett, 1851 (Gastropoda)

by

Jindrich NOVÁK (1), Lubomír HANEL (2) & Oldrich RÍCAN (1)

RÉSUMÉ. - *Formosania* : un nom de remplacement pour *Crosso - stoma* Sauvage, 1878 (Teleostei), homonyme junior de *Crossosto - ma* Morris & Lycett, 1851 (Gastropoda).

Le nom générique *Crossostoma* Sauvage, 1878 (Teleostei, Balitoridae) est préoccupé par le nom *Crossostoma* Morris & Lycett, 1851 (Gastropoda). Le remplacement du nom *Crossostoma* par le nom *Formosania* est recommandé pour ce genre de Balitoridae de l'Asie du sud-est.

Accepted by Molecular Phylogenetics and Evolution

Molecular phylogeny and biogeography of the Neotropical cichlid fish tribe Cichlasomatini (Teleostei: Cichlidae: Cichlasomatinae)

Zuzana Musilová [a, b, *], Oldřich Říčan [b, c], Karel Janko [b], Jindřich Novák [c]

[a] Department of Zoology, Charles University in Prague, Viničná 7, 128 44, Praha, Czech Republic

[b] Institute of Animal Physiology and Genetics of the Academy of Sciences of the Czech Republic, Rumburská 89, 277 21, Liběchov, Czech Republic

[c] Department of Zoology, Faculty of Biological Sciences, University of South Bohemia, Branišovská 31, 37005, České Budějovice, Czech Republic

* corresponding author. E-mail address: zuzmus@email.cz

Abstract

We have conducted the first comprehensive molecular phylogeny of the tribe Cichlasomatini Kullander, 1998 including all valid genera as well as important species of questionable generic status. To recover the relationships among the cichlasomatine genera and to test their monophyly we analyzed sequences from two mitochondrial (16S rRNA, cytochrome b) and one nuclear marker (first intron of S7 ribosomal gene) totalling 2236 bp. Our data suggest that all genera except *Aequidens* are monophyletic, but we found important disagreements between the traditional morphological classification and the phylogeny based on our molecular data. Our analyses support the following conclusions: a) *Aequidens* sensu Kullander, 1989 is paraphyletic; b) *Krobia* is probably the sister group of *Aequidens/Cichlasoma* and includes also the Guyanan *Aequidens* species *A. potaroensis*. c) *Bujurquina* and *Tahuantinsuyoa* are sister groups, closely related to an undescribed genus formed by the *'Aequidens' pulcher – 'Aequidens' rivulatus* groups; d) *Nannacara* (plus *Ivanacara*) and *Cleithracara* are found as sister groups. The relationships between the four major clades and the genera *Laetacara* and *Acaronia* are difficult to resolve due to conflict between mitochondrial and nuclear markers. Estimation of divergence times suggests that genera of Cichlasomatini have diverged about 31 MYA. Based on the most parsimonious reconstruction of the biogeographic data we assume that the ancestral area of Cichlasomatini was in the Guyana highlands area.

Submitted to Behaviour

Social Deprivation in Fishes Illustrated on *Tropheus* Mouthbrooders (Pisces, Cichlidae)

Jindrich Novak

Biological Faculty, University of South Bohemia, Branisovska 31, 370 05 Ceske Budejovice, Czech Republic

Keywords: artificial incubating, breeding, cichlids, deprivation, fishes, mouthbrooders, parental care

Summary

Five colour phases of populations presently not assigned to species and identified only informally by their presumed distributional limits of mouthbrooding cichlids (family Cichlidae) of the genus *Tropheus* were tested to see whether a state of social deprivation can be triggered. The influence of parental care upon psychosocial development of the fry was confirmed experimentally. An important part of development of the behaviour patterns is the process of offspring learning during the parent-contact spell. The results confirm a fact of importance to ornamental fish breeders that artificially reared cichlid mouthbrooders reproduce less readily. Artificial hatching devices are harmful to the offspring of mouthbrooding fish species and their use can be deemed acceptable only in certain cases of species conservation or experimental endeavors.