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Aspects of social behavior in Poecilia latipinna (Lesueur)*

by

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ABSTRACT: Agressive and courtship behavioral patterns are prominent in the repertoire of *Poecilia latipinna,* a small poeciliid fish of shallow subtropical North American coastal waters. Courtship involves a characteristic set of behavioral patterns in which the male plays a dominant role; the species is sexually dimorphic, and morphological differences play important roles in courtship. Aggressive behavior has been observed in both sexes, and has been linked to both feeding and courtship. Size and sex are important in dominance determination, and in confined areas, especially at low population densities, stable hierarchies are formed. The role of aggressive behavior in the social structuring or organization of populations is discussed, as well as some differences between certain freshwater and marine populations.

A predictive theory of population and community ecology may be developed from the assumption (LEVINS, 36) that in populations of organisms changes in gene frequencies with time are primarily adaptively directed as a consequence of natural selection. By logical extension such adaptive direction should result in a composite of attributes in a population which together allow it to continue to persist in a given environment. This set of attributes of undefined dimension can be envisioned as an integrated "plan" or "adaptive" strategy which encompasses all phenotypic traits in the population. Theoretically, given the requisite environmental information, a measure of "fitness" can be assigned to each possible combination of phenotypic attributes and an "optimum" strategy predicated. At

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present, our degree of predictability is severely limited by the current state of ecological knowledge. By examining attributes of natural (and experimental) populations however, progress can be made toward a more fundamental understanding of the nature of "adaptive" strategies, "fitness", and the "environment", particularly in regard to patterns of animal behavior.

Behavioral atributes must contribute significantly to the fitness (*sensu* MACARTHUR, 39) of individuals in a given population. The present intention is to examine the role of certain aspects of social behavior, namely agression and courtship, in the "adaptive" strategy of the viviparous fish *Poecilia latipinna* (Lesueur) emphasizing particularly the interaction and integration of ecological and social factors in the population dynamics of the species.

COURTSHIP

Social behavior can be defined most broadly as the behavioral interaction among individuals of a species population, the perfomance of which changes in some measurable way the spacing of such individuals in time and space. The behavioral interaction is usually quite specific and many authors have emphasized spacing aspects of social behavior (COLLIAS, 15; CROOK, 16; ITO, 33). In poeciliid fishes social behavior usually involves stereotyped behavioral patterns which are markedly sexually dimorphic. Courtship, a form of social behavior, plays a prominent role in the behavioral repertoire of poeciliids (CLARK *et al,* 14; LILEY, 37; FRANCK, 22) and *P. latipinna* males display elaborate courtship behavior in association with sexually dimorphic fin morphology and color patterns (Fig. 1). In particular, the structure and function of the male gonopodium (anal fin) and elongate pelvic fins involved in the transfer of sperm to the female urogenital opening during the final stages of courtship is well documented (ROSEN and GORDON, 52; CLARK *et al,* 14; ROSEN and BAILEY, 51).

The principal ethological components of male courtship are outlined in Fig. 2. The initial phase consists of "approaching" in which the male rapidly approaches a single female. If the female continues to move the male will continue the pursuit-like "approach" phase. The second most conspicuous part of male courtship is "check-displaying" in which the male orients at right angles to the female, presenting the fully extended dorsal fin and lateral body coloration. The body assumes an inward curving posture and the male shimmers slowly in front of the female often rapidly switching from side to side while maintaining a position normal to her (Fig. 2b). "Check-display" is most often followed by "anal nipping" in which the male nips the female urogenital area repeatedly with the mouth (Fig. 2c). Gonopodial "waving" (CLARK *et al.,* 14) is often observed during this time. Copulation involves "thrusting" in which the male attempts to deposit sperm in the female genital tract with the gonopodium (Fig. 2d). Thrusts do not always lead to successful copulation and it appears that receptive females often rotate the ventral part of their bodies toward the males. The courtship sequence is not rigidly fixed but appears arranged in a probability hierarchy in which a given component may be followed by any of the other components. The order described above is the "complete" sequence. However, in nature and particularly in small aquaria "anal-nipping" and "thrusting" frequently occur without "check-display".

The behavioral role of the female in courtship is less physically active and appears to consist of indicators of receptivity. Females which appear receptive respond to courtship by remaining motionless and rotating the ventral body surface toward a "thrusting" male. Personal observation indicates that males seldom court pregnant females and in aquaria females are courted vigorously for several days following parturition. Receptivity in the female appears then to facilitate male courtship though the behavioral details remain to be fully documented. A number of studies indicate that female feedback is critical in the courtship sequence of poeciliids (also other cyprinodontiforms; WALTER and HAMILTON, 56), and suggest some of the possible discriminatory cues which may be involved. HUBBS (31) has shown that males of *P. latipinna* discriminate best between large conspecific females and the sympatric all-female species *P. formosa.* In addition, males from sympatric populatoins were better able to discriminate than those from allopatric (with *P. formosa*) ones. CLARK *et al.* (14) found that female receptivity in *Xiphophorus* affects copulation frequency and other elements of courtship behavior in the male. Guppies (*P. reticulata*) rapidly learn to discriminate between females of other related species (BASTOCK, 9). LILEY (37) has described distinct motor patterns of female receptive behavior in certain species of *Poecilia* (e.g. *P. reticulata*) and their importance as isolating mechanisms. CARLSON (13) and PEDEN (48) have outlined the cyclic variation of anal spots with oögenesis in *Gambusia* and the marked facilitation of male "thrusting" in response to the presence of anal spots. MENZEL and DARNELL (43) describe anal melanophores in females of *P. mexicana,* a sub-generic relative of *P. latipinna.* REID (50) has shown that *Gambusia* responds to olfactory stimuli (alarm substances), and pheromones must also be considered, though vision appears to be the primary sensory mode for reception of courtship stimuli in *Poecilia.*

AGGRESSIVE BEHAVIOR

Aggressive behavior has been described in detail by BAIRD (5) for both *P. latipinna* and *P. formosa* including its role in the social structuring or organization of populations. Aggressive behavior consists of "threat display" followed by a "nipping" and "chasing" sequence commonly observed in many fishes. The median fins are erect in the display phase and occasionally "tail beating" between evenly matched males is observed. Aggressive behavior results in a dominant-subordinate relationship between individuals, and in groups a social hierarchy is established. Hierarchies are "straight-line" (*sensu* BRADDOCK 11) and nipping is a "peck right" (*sensu* COLLIAS, 15) as opposed to the "peck dominance" social order more characteristic of territorial fishes. Both sexes exhibit aggressive behavior and either sex can occupy any rank in the social order. Fighting which resulted in physical injury was never observed and aggressive behavioral patterns appear classically "ritualized" and "emancipated" (BLEST, 10). Size and sex are important determinants of social dominance with large male fish having the highest probability of being socially dominant. Prior residence was effective in dominance relationships in the field and aggressive behavior was linked to both courtship and feeding.

Population density had marked effects on aggressive behavior in aquaria. As population density increased aggressive behavior decreased, particularly in the females, and even at relatively low densities (ca. 15 individuals) female aggressive behavior was greatly reduced. The males exhibited some aggressive behavior at all densities examined. However, as density increased male aggressive behavior was directed primarily toward other males and male hierarchies could be discerned over a wide range of density situations. Males were more aggressive than females particularly when both sexes were present. Feeding, especially when food was spatially localized, facilited aggressive behavior in both aquarium and natural populations with both sexes participating. Territoriality (*sensu* COLLIAS, 15) was occasionally observed under the special circumstance of spatially localized food. In the field, males often defended a "territory" against other males though the defended area was not fixed but centered around the individual. Similar behavior has been described for *Xiphophorus* (BAERENDS, 3). Aggressive behavior was variable in frequency and duration of occurrence within and among individuals in both aquaria and field situations. "Appeasement" behavior was observed in low density groups in small aquaria. Such behavior was often ineffective under these conditions in male-male encounters and very high incidences of aggressive behavior are often observed (DUNHAM *et al.*, 19).

ENDOCRINE AND GENETIC FACTORS

The endocrine control of reproduction has been extensively documented in teleost fishes (PICKFORD and ATZ, 49; BALL and BAKER, 7; HOAR, 29) and physiological evidence supports the hypophyseal control of gametogenesis. Studies by PANDAY (46, 47) on *P. reticula* indicate that the pituitary directly regulates androgen production by the testis and that gonadal androgens have marked effects on the development of secondary sex characters in juvenile males. Once the morphological development of the dimorphic fin characters is complete, however, hypophysectomy does not appear to result in regression, though there is a loss of yellow and red pigments and marked effects on the testes. Hypophysectomized guppy females show immediate and total decline in sexual behavior though gonadectomized females are sexually active for at least five months (LILEY, 37). Hypophysectomy of gravid female *P. latipinna* has little effect on the subsequent birth of normal young, however, suggesting relative independence of embryonic development and hypophyseal gonadotropin secretion

(6). GRIER (27) has recently demonstrated that photoperiod and temperature are critical control mechanisms in *P. latipinna.* When the daily photoperiod approaches a 12:12 L:D cycle hypophyseal gonadotropin secretion terminates, resulting in cessation of oöcyte development and vitellogenesis. Temperature is effective in inhibition of photoperiodic induction of vitellogenesis. Chemical inhibition of pituitary gonadotropic functon (Methallibure) totally inhibited oögenesis in females while spermatogenesis was not completely inhibited. Spermatogenesis was not completely inhibited by photoperiod in both experimental and field situations, indicating a somewhat different mode of endocrine control in the male as spermatogenesis can apparently occur at extremely low levels of gonadotropin secretion.

The endocrine control of aggressive behavior is less completely documented in fishes but gonadotropins, androgens, and adrenal corticoids all appear to be involved (DAVIS, 18; BASTOCK, 9; HOAR, 29). Aggressive behavior is involved with hunger-satiation (feeding) control mechanisms as well as reproduction in *P. latipinna* (BAIRD, 5) and some evidence exists that sexual and feeding behavioral centers are laterally juxtaposed in the hypothalamus and limbic regions of the telencephalon in mammals (9). Of critical importance is the finding that exposure to aggressive behavior has marked physiological (endocrine) effects in mammals (ELEFTHERIOU and SCOTT, 20; THIESSEN, 54). By extrapolation and from the known effects of the "social" environment on aggressive behavior in *P. latipinna* there are probably marked endocrine changes via environmental feedback in poeciliids as well.

While much remains to be documented, what emerges from a consideration of endocrine control mechanisms in *P. latipinna* is that the hypothalmo-hypophyseal-gonadal axis (*sensu* GRIER, 27) is a versatile, flexible system which appears to enable the individual to respond to a wide variety of external environmental stimuli. (ZAMBRANO, 58; VLAMING, 55). The responses range from "fine tuning" to predictable long range environmental cues (e.g. photoperiod, temperature) and to less predictable ones arising from local environmental effects (e.g. food resources, predation, population density, sex ratio). Appropriate social behavior patterns are of course intimately linked to these responses and have been integrated into the total control mechanism.

Documentation of genetic control of behavior is non-existent for *P. latipinna* though personal observation indicates that Texas and Florida estuarine and freshwater populations are not markedly different as regards courtship and aggressive behavior patterns. Evidence from studies with xiphophorin fishes, particularly hybridization experiments, suggest the following concerning the genetic basis for social behavior patterns. Species specific behavior patterns are remarkably stable irrespective of environmental conditions and changes in genetic background. Inheritance appears under polygenic control with genes widely distributed in the genome. Component patterns of behavior are often inherited independently, and in hybrids, patterns of maternal and paternal origin are generally displayed alternatively instead of integrated into a single complex movement (CLARK *et al.*, 14; FRANCK, 23, 24). The emergent picture therefore is one in which the motor patterns, morphological components, and releasing stimuli-coding mechanisms (HAILMAN, 28) are fully integrated in a balanced genome (*sesu* MAYR, 41) of considerable stability.

A consideration of genetic and endocrine control of social behavior in ***P. latipinna*** in relation to the "environment" and individual fitness can now be put in perspective. A growing body of evidence indicates that motivational, motor pattern, and morphological changes or abnormalities may greatly alter the effectiveness of a given behavioral display in its normal social context (see review by BASTOCK, 9). Hence the intensity of social selection has been recognized by many authors (e.g. CROOK, 16; KUO, 35) with the implication that non-conformity to genetically determined forms of intra-specific communication greatly reduces individual fitness. This hypothesis would predict that motor patterns, morphological components, and releasing stimuli-coding mechanisms of stereotyped behavioral sequences would exhibit considerable stability (low variability) within a population and that this stability would be enhanced by polygenic inheritance in a balanced genome. However, while gentic control mechanisms appear to produce the requisite behavioral stability such inflexibility when applied to the performance of behavior in time and space could lead to "inappropriate" responses in a changing environment with consequent reduction in fitness. The hypothalamo-hypophyseal-gonadal axis provides the essential flexibility wherein the individual can respond appropriately to the total physical and social environment.

COURTSHIP AND REPRODUCTIVE STRATEGY

The adaptive role of courtship behavior in *P. latipinna* can perhaps best be examined within the context of the viviparous reproductive strategy of the species. A viviparous strategy involves internal fertilization and the problem of intromission and gamete transfer. The evolution of the male gonopodium has provided the required morphological structuring. Behaviorally, however, intromission appears to require active participation of both sexes in which the female must at least remain relatively motionless for some period of time. Internal fertilization eliminates requirements for a specific egg laying site or nest area while vivaparity greatly increases egg and larval survival. Territoriality in regard to spawning sites (also post-mating parental care behavior) is absent in *P. latipinna* though common in shallow water cyprinodontids (BREDER and ROSEN, 12).

Data obtained from natural and experimental populations indicate that the reproductive season for *P. latipinna* extends from February to October (27, 31) in Texas and Florida. Females have multiple broods over a single season, and sexual maturity is probably attained in females after about 90 days. Gestation takes about 30 days (27, 31). In addition, GRIER (27) indicates that the onset of reproduction in February to March varies considerably among individual females and results of experimental induction of reproduction by photoperiod suggest similar variability. The resultant conclusions are that there is a considerable period of time (gestation) when courtship behavior by either sex would probably reduce fitness in regard to an individual female, females are not in reproductive synchrony even though peaks of reproduction may occur (27), and additional mature females are being added to the population later on during a long breeding season. These reproductive and life history features appear to place a number of selective constraints on courtship behavior. A feedback system indicating female receptivity in a non-synchronously reproducing population would appear to be one such constraint. High motivational levels in the male particularly in response to indications of receptivity in the female is another, while mutual facilitation of reproduction through courtship behavior considering the mechanical problems of sperm transfer is yet another. In addition, the mutual facilitation and discriminatory feedback of courtship can function as an ethological isolating mechanism (37) in areas of sympatry with close relatives (e.g. northern Mexico; MENZEL and DARNELL, 43).

While further documentation is required concerning the female role in courtship, the essential feedback requirements are predicted by considerations outlined above. The high motivational level of the males has been indicated for other poeciliids, including the inefficiency of isolating mechanisms in many instances (32). Comparison of courtship patterns with other poeciliids should contribute to an understanding of the evolution of such patterns in the family and suggest some of the selective forces operating on patterns of courtship in *P. latipinna.* ATZ (2) has remarked on the difficulties in applying the concept of homology to behavioral characters (however, see FRANCK, 22, and GORMAN, 26) and the suggested comparison is not necessarily to determine behavioral phylogeny but primarily to indicate the major differences and similarities between species and some of the possible ecological factors invovled.

Courtship behavior has been most thoroughly studied in *P. reticulata* (BAERENDS *et al.*, 4; LILEY, 37), *Xiphophorus* (CLARK *et al.*, 14; FRANK, 22) and *Gambusia* (HUBBS, 30, 32; PEDEN, 48). While any extensive comparison is beyond the scope of this review it can be noted that there are similar elements in the courtship sequences. All, as expected, exhibit "thrusting" behavior while "checking" and "anal nipping" occur frequently. Female receptivity has been indicated (citations above) as well as high motivational levels in the male. While ecological and population studies are not extensive in poeciliids, a comparison between *Gambusia* and *P. latipinna* concerning courtship behavior is instructive. *Gambusia* are predatory poeciliids which are found (or have been introduced) in a wide range of environments. While most numerous near shore they appear to occupy positions in the water column near the surface and are quite active during much of the day (32). *P. latipinna* is primarily an herbivore and detrital feeder (17), relatively inactive, and is most numerous in habitats where predation appears low (5). The elaborate courtship sequences and striking sexual dimorphism of *P. latipinna* have been described. By contrast, courtship in *Gambusia* appears to consist primarily of "thrusting" behavior, sexual dimorphism is considerably less striking, and anal spot patterns are important elements in female receptivity feedback. Considering the probable differential exposure to predation by activity and position in the water column (feeding ecology) speculations as to selective forces shaping the reduced courtship ritual in *Gambusia* are inviting and illustrative of the possible effects of niche parameters on the social behavior and structure of particular species.

AGGRESSIVE BEHAVIOR; REPRODUCTIVE AND ECOLOGICAL CONSIDERATIONS

The adaptive role of aggressive behavior in *P. latipinna* is somewhat more difficult to explore because while descriptive data exist, little has been done relating aggression to measures of fitness in any quantitive way. Aggressive behavior is widespread in poeciliids (9, 11, 42) and appears to be an important component of social behavior in *P. latipinna*. Social dominance, which is mediated through aggressive behavior, would appear to enhance individual fitness by reason of higher reproductive success in dominant individuals, which behaviorally reduce access to the opposite sex by subordinates (particularly in males) though this requires further documentation. The "prior residence" effect and the resultant spacing of males in the environment (5) is of considerable importance in this regard. The implication is that subordinate individuals, especially males, are excluded from "optimum" environments thereby reducing their reproductive contribution to (possibly removing them from) the resident breeding population (see HUBBS, 32 and THEISSEN, 54, for further discussion).

Aggressive behavior is also associated with feeding behavior. A number of authors have discussed the effect of dominance as it relates to competitive advantage under varying environmental conditions (e.g. ALLEE, *et al.*, 1; MAGNUSON, 40, BARLOW, 8). Under conditions of deprivation and spatial limitation of food and low population density, the differential rates of growth between dominant and subordinate fish appear maximized though quantitative data for *P. latipinna* are lacking. Spatial exclusion of subordinate individuals and hierarchical organization through aggressive behavior, particularly in males, could affect utilization of resources. Subordinate individuals could be forced to "suboptimal" habitats thereby reducing demand in optimal environments. Hierarchic organization with individual recognition and stability could lower energy demands through reduced duration of actual aggressive behavior, thereby reducing resource intake by dominants and thus possibly increasing resource availability to subordinates.

Extensive extrapolation from other species indicates that aggressive behavior may be a fundamental control mechanism in population regulation in *P. latipinna*. Aggressive behavior is density-dependent and affects the spatial distribution of individuals in natural environments, particularly males. Food deprivation, sex ratio, and courtship have all been implicated with different levels of aggressive behavior (5). These observations are not of course unique to this species (Collias, 15; Southwick, 53; Fenderson and Carpenter, 21). The effect of aggressive behavior on hormonal and endocrinal systems (see citations above) provides the plasticity whereby individuals can respond to the social as well as the physical environment. Appropriate responses can therefore be made to the combined physical and social environment. Aggressive behavior may therefore act as a form of "communication" about the current "state" of the population, particularly to young or maturing individuals, thereby exerting a regulatory role, including one of dispersal (Ito, 33). Balanced polymorphism (8), movement and stability of hierarchic membership (Myrberg, 45) and possibly sex regulation through visual feedback (Geodakian and Kosobutzky, 25, for *P. reticulata*) have implicated aggressive behavior. Baird (5) has suggested that the number of dominant males (and possibly receptive females) could affect the timing of maturation of males in *P. latipinna* through visual and behavioral feedback. Further speculation here is premature but guidelines for future research are indicated.

SOCIAL BEHAVIOR, ADAPTIVE STRATEGIES, AND NATURAL POPULATIONS

While ecological studies of *P. latipinna* are not extensive there is sufficient information to suggest some of the ways social behavior is integrated into adaptive strategies. The relationship among available resources, population characteristics, size of individual, and social behavior will be examined in this regard. While many of the relationships have not been quantified and much more data are required, the present results do provide a framework around which further scientific inquiry can progress.

Table 1 presents some preliminary data on the mean size of individuals taken from two habitats in Central Florida. Fishes were collected with a fine-mesh minnow seine in late November, well after the close of the breeding season. No small juveniles were present, distributions for each sex were unimodal and both populations had a similar breeding season (27). The data indicate a marked difference in mean size of individuals between the fresh water Hillsborough River (Sample 1) and the estuarine Ninth Street location (Samples 2 and 3) and may well reflect a difference in available resources in the two populations. Hubbs (32) found definite mean individual size differences between habitats in *Gambusia*. The effect of freshwater competitors on available resources has been suggested for a number of poeciliids (32, 44). The short life span and the contribution to fitness of age at first reproduction (Wilson and Bossert, 57) probably limit time for maximum growth to the period prior to sexual maturation in both sexes. Table 1 indicates strong correlation between sizes of both sexes in a single population.

TABLE 1

Size distribution of P. latipinna *from different localities and times*

Sample	Sex	Locality	Season	N	$\bar{x} \pm$ Sd
1a	female	Hillsborough River	November	124	43.7 ± 7.2
b	male	" "	"	42	38.8 ± 8.6
2a	female	9th Street	November	42	51.9 ± 5.2
b	male	" "	"	21	46.2 ± 5.7
3a	female	9th Street	December	49	54.7 ± 7.4
b	male	" "	"	57	56.0 ± 8.8

Statistics: All distributions were unimodal and symmetrical. F test for population variance was significant only between populations 1a and 2a ($.05 > p > .01$).

T — tests

Populations	T	Significance
1a, b	2.94	$P < .05$
2a, b	3.75	$P < .01$
3a, b	0.81	NS
1a, 2a	6.67	$P < 0.001$

Social dominance and sexual attractiveness would appear to favor larger size in the female (also other non-behavorial fitness contributions such as fecundity). However, given the constraints of age at first reproduction and seasonal variation in available resources it would appear that only at low population densities or possibly in the presence of a sympatric sexual parasite (*P. formosa*) would behavioral factors be expected to exert a pronounced influence on individual size. In the male, however, the increased role of social dominance and active courtship would indicate a more pronounced effect of social behavior on size determination. Sex ratios in populations of *P. latipinna* strongly favor females in most seasons and increased predation (possibly other factors as well) on the more active, conspicuous males has been implicated in this regard for other poeciliids. Exposure to high levels of predation in populations of *Gambusia* has marked effects on both sex ratio and mean size of males (smaller as compared to populations with low predation; KRUMHOLZ, 34). As growth ceases at maturity in males, the timing of maturity would have a marked influence on individual size. At low and medium popualtion densities hierarchical organization would be most pronounced and delayed maturity (increase in size) probably favored. At high population densities this effect would be less extreme. Assuming a visual feedback mechanism whereby the number of receptive females and/or aggressive males affect endocrine systems in subordinate juveniles, early maturation (smaller size) would be favored where the former was high and the latter low. As the number of maturing females increases over the course of the breeding season (non-synchronously) earlier maturation and smaller males could be expected (also when mature males are continuously removed via predation). During the winter when reproduction ceases, early maturation makes no immediate contribution to individual fitness and delayed maturation is expected to be favored by reason of social dominance. Preliminary results summarized in Table 1 indicate that in November, males were smaller than females at the Ninth Street locality. In late December, however, males were as large as females. This was when the young of the year had sufficient time to reach sexual maturity.

Preliminary results of studies of estuarine populations in summer months indicate that there appear to be a number of "supernumerary" males present in the population. These are small males in which gonopodium and pelvic fin development indicate sexual maturity (Fig. 3) and in captivity such individuals actively court females. The dorsal fin is not as high (Fig. 3) nor does it have the characteristic pigmentation seen in morphologically fully developed males. In aquaria no further development of the dorsal fin was observed over a three-month period. Whether such males are in fact sexually mature, or whether morphological development proceeds in such a way that growth and the development of the full dorsal fin and coloration is a rapid last step in the maturation process, requires further documentation. Larger males in intermediate stages of morphological maturation are present in the population (Fig. 3). Smaller, less highly colored males are observed "thrusting" in natural populations. In high densities, hierarchic organization is less pronounced, mean distance between males reduced, and supernumerary males less likely to provide stimuli-eliciting aggressive behavior or predation yet are able to contribute significantly to reproduction. Data presented by HUBBS (31) and GRIER (27) indicate that reproduction in natural populations is maintained near maximum (nearly 100 % of mature females fertilized) and much remains to be learned concerning behavioral factors operating on male maturation in *P. latipinna.*

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RESUMEN

Los patrones de agresividad y de cortejo son muy marcados en *Poecilia latipinna,* un pez poecílido pequeño de aguas subtropicales poco profundas de las costas de América del Norte. El cortejo se caracteriza por un conjunto de patrones de comportamiento en los que el macho desempeña un papel dominante; la especie es sexualmente dimórfica y las diferencias morfológicas son de gran importancia en el cortejo. El comportamiento agresivo ha sido observado en ambos sexos y se le ha ligado tanto a los hábitos de alimentación como al cortejo. El tamaño y el sexo son determinantes en la dominación, y en áreas confinadas, especialmente a bajas densidades de población, se forman jerarquías estables. Se discute el papel que juega el comportamiento agresivo, tanto en el establecimiento u organización social de las poblaciones, como las diferencias que existen entre las poblaciones de agua dulce y las marinas.

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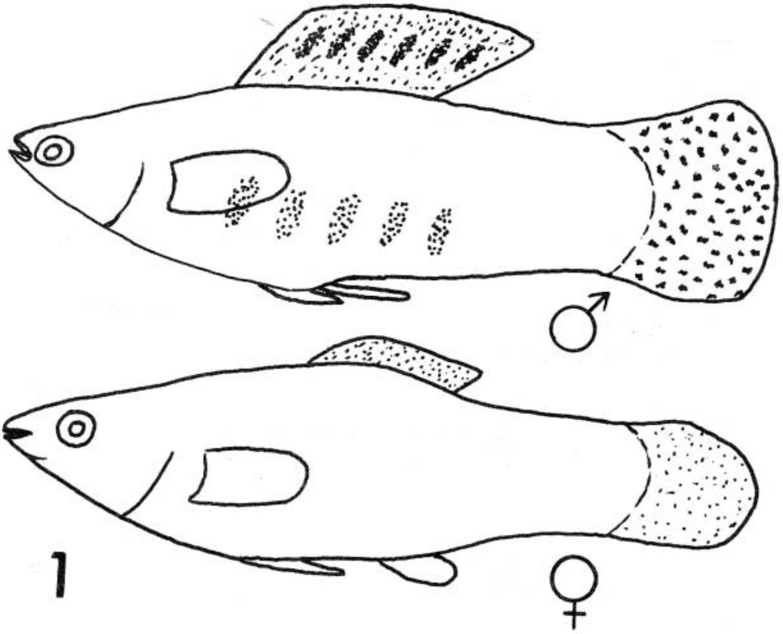
Fig. 1. *Poecilia latipinna* (Lesueur)
Dimorphic fin morphology and color patterns.

Fig. 2. Courtship behavior in *Poecilia latipinna*
a. "Approaching"
b. "Check-displaying"
c. "Anal nipping"
d. "Thrusting"



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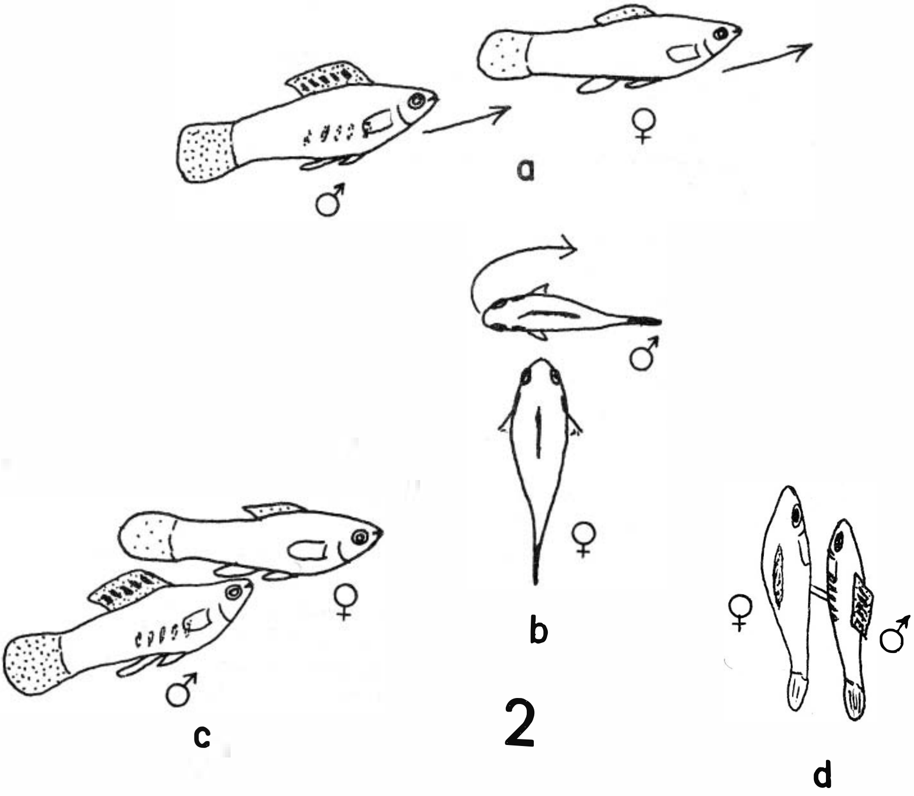

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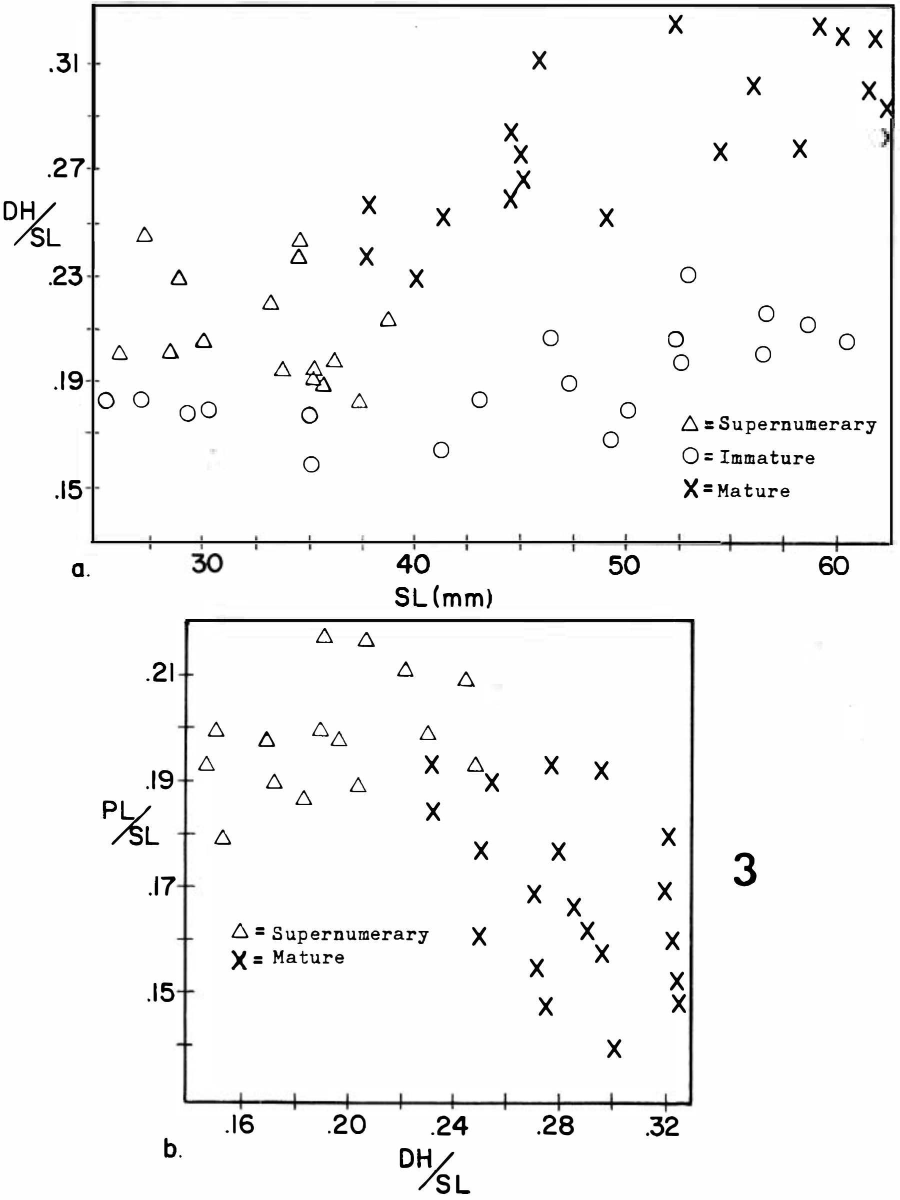
Fig. 3. Development of dimorphic fin morphology in *P. latipinna* males: a. Ratio of height of dorsal fin (DH) and standard length (SL) in relation to SL for three stages of male maturity. b. Ratio of pelvic fin length (PL) and SL in relation to DH/SL for "supernumerary" and mature males.


.31
.27
DH/SL
.23
.19
.15
△ = Supernumerary
○ = Immature
X = Mature
a.
30
40
50
60
SL (mm)
.21
.19
PL/SL
.17
.15
△ = Supernumerary
X = Mature
.16
.20
.24
.28
.32
b.
DH/SL

3

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