

**“Greeting” Behavior in Tiger Salamanders
(*Ambystoma tigrinum* and *Ambystoma mavortium
mavortium*)**



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Abstract

Agonistic (aggressive) and placatory (peace-keeping) interactions, as well as courtship behavior, have been described for Ambystomatid (mole) salamanders. There are field and laboratory studies on the courtship behavior of tiger salamanders (*Ambystoma tigrinum*, *Ambystoma mavortium* subspecies), and some on territorial and denning habits, but peer-reviewed studies on interactions are largely lacking beyond the larval stages. Here, more anecdotal observations are described showing a sequence of visual gestures and interactions between metamorphosed juvenile and adult tiger salamanders that have the appearance of a formal greeting. This paper documents this photographically, addresses changes in “greeting” behavior with time and examines traces of this behavior in the salamander courtship and neuroendocrinology literature. Though the focus is on tiger salamanders, literature on other Ambystomatid salamander species is utilized as well as information from non-Ambystomatid species where information on tiger salamanders or any Ambystomatidae is lacking.



Tiger salamanders are a group of burrow-dwelling “mole salamanders”, order Ambystomatidae, genus *Ambystoma* that include the eastern tiger salamander/*A. tigrinum*, the western or barred tiger salamander/*A. mavortium* and its subspecies, the California tiger salamander/*A. californiense* and the plateau or Mexican tiger salamander/*A. velasci*). For salamander keepers and scientists alike, there is just not enough scientific information about metamorphosed juvenile or adult tiger salamander social behavior.

The majority of behavioral studies on eastern or western/barred tiger salamanders (and *A. mavortium* subspecies) involve larval stage interactions or courtship of adults. There are journal articles and anecdotal descriptions in herpetoculture magazines as well as articles, photos and videos on websites showing co-denning and interacting (Gehlbach et al., 1969; Titus et al., 2014; some Caudata.org album or blog pages are listed under References; Chernoff 2016).

Keepers report that with regular feeding and congenial terrarium setup eastern or western tiger salamanders not only tolerate each other well, but den together (Chernoff, 1999b). Young metamorphosed tigers do go through a “nippy phase” when they enthusiastically bite the food item-scented hand that feeds them and will bite their terrarium mates on the snout or limbs if they get in the way of a food item. Even adult tigers will grab a cricket from a terrarium mate’s jaws, land a mucus-covered tongue on a neighbor’s head, or bite in a feeding frenzy, but they are usually more than tolerant of a cage-mate.

Based on what scientific literature there is on the topic, and on anecdotal observations of captive/pet tiger salamander behavior, a question that I would like to have answered is whether tiger have specific, formal social behavior that allows them to cohabit peacefully. The existence of some undescribed formal *intraspecies* social behavior that potentiates peaceful tiger salamander cohabitation could also underlie *interspecies* social behavior involving tiger salamanders. The interspecies interactions to be explained include their ability to cohabit with small mammals (rev Chernoff 2016. Link in Refs; Video link in Chernoff and Macke 2017. <https://peecnature.org/salamanders/>) as well as the ease with which tiger salamanders become tame and interact with their keepers. In nature such *intraspecies* behaviors could occur either in inconspicuous interactions between individuals on the surface or underground in group burrows and would not be easy to study.

The Ambystomatid salamander literature shows the existence of a variety of visual gestures and even vocalizations in land-dwelling forms that are used in confrontations/social interactions of many *Ambystoma* species. Unfortunately, there are no corresponding studies for tiger salamanders, beyond showing “site tenacity” (e.g.: persistent occupation of burrows in a specific area) in territorial behavior studies (rev. in Mathis et al., 1995; Chernoff 2000; Walls 2007).

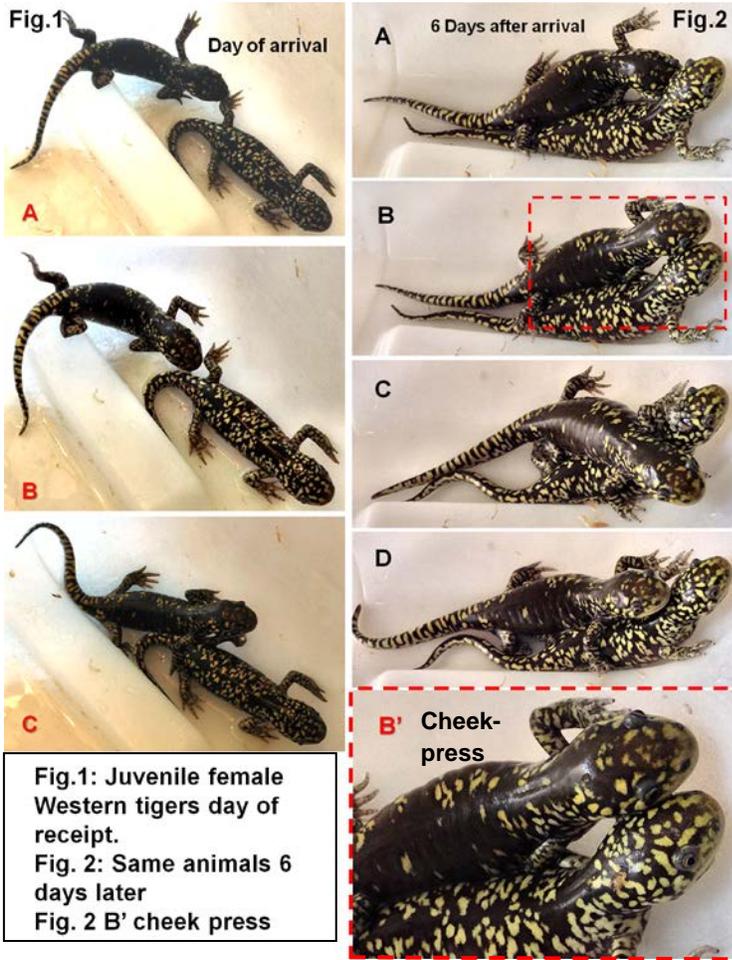
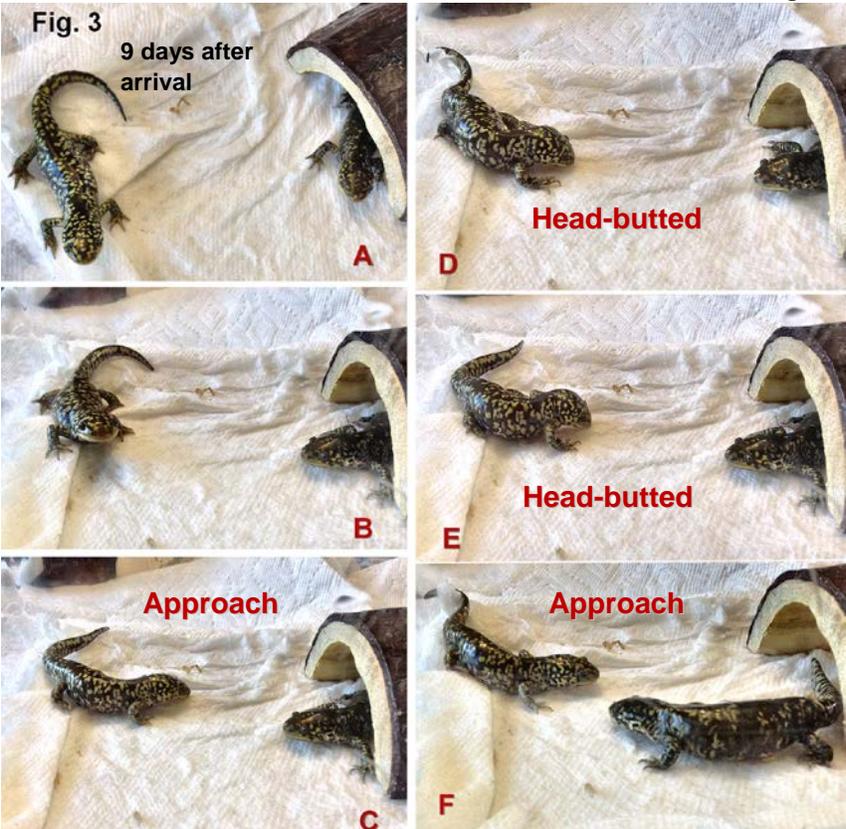


Fig.1: Juvenile female Western tigers day of receipt.
 Fig. 2: Same animals 6 days later
 Fig. 2 B' cheek press

What follows is my report of what appears to be greeting behavior, with photographic documentation and an attempt to link that to published studies on other behavior of other Ambystomatid species. The predominant gestures in the "greeting" are: tapping each other with the snout, head rubbing and pressing together at the cheek. Nose-tapping both the substrate and other salamanders of the same species is relatively common among Ambystomatid salamanders (Ducey, 1989: *A. opacum*, *macrodactylum*, *tremblayi*, *talpoideum*; Ducey and Ritsema, 1988: *A. maculatum*), but, again, not described for tiger salamanders.

My current pet tiger salamanders, mostly western tigers, *Ambystoma mavortium*



mavortium, and one Eastern tiger (*Ambystoma tigrinum*) range in age up to 17 years old. I have developed the habit when getting pairs of young metamorphs of watching them interact as they settle, tame and mature. I have described an interaction sequence previously, but had not been able to document it photographically (Chernoff, 1999b, 2016). The interaction sequence

Figure 3 A-O. Start: A-F. Two young female barred tiger salamanders perform a sequence of visual gestures as they come together.

in Figure 3 shows two western tiger salamanders from Florida. It is not known whether they were housed together before shipment. They weighed 10-12 gram each upon arrival. The first sequence was from the day they arrived (11/25/16). They were unpacked, fed crickets and left to settle separately for about an hour. Then they were placed in a large bowl (23 cm X 23 cm). Clock-girl (fewer yellow markings) approached Hamster from behind and touched/sniffed a foot and the tail or cloaca (Figure 1). They were housed together in a terrarium with New Zealand sphagnum moss, with a single shelter, but they dug in and rested separately. They were fed daily at this point. The two salamanders were removed from the terrarium and placed in the bowl again 6 days later after their regular feeding and a rest period (12/01/16 Figure 2). In this sequence Clock-

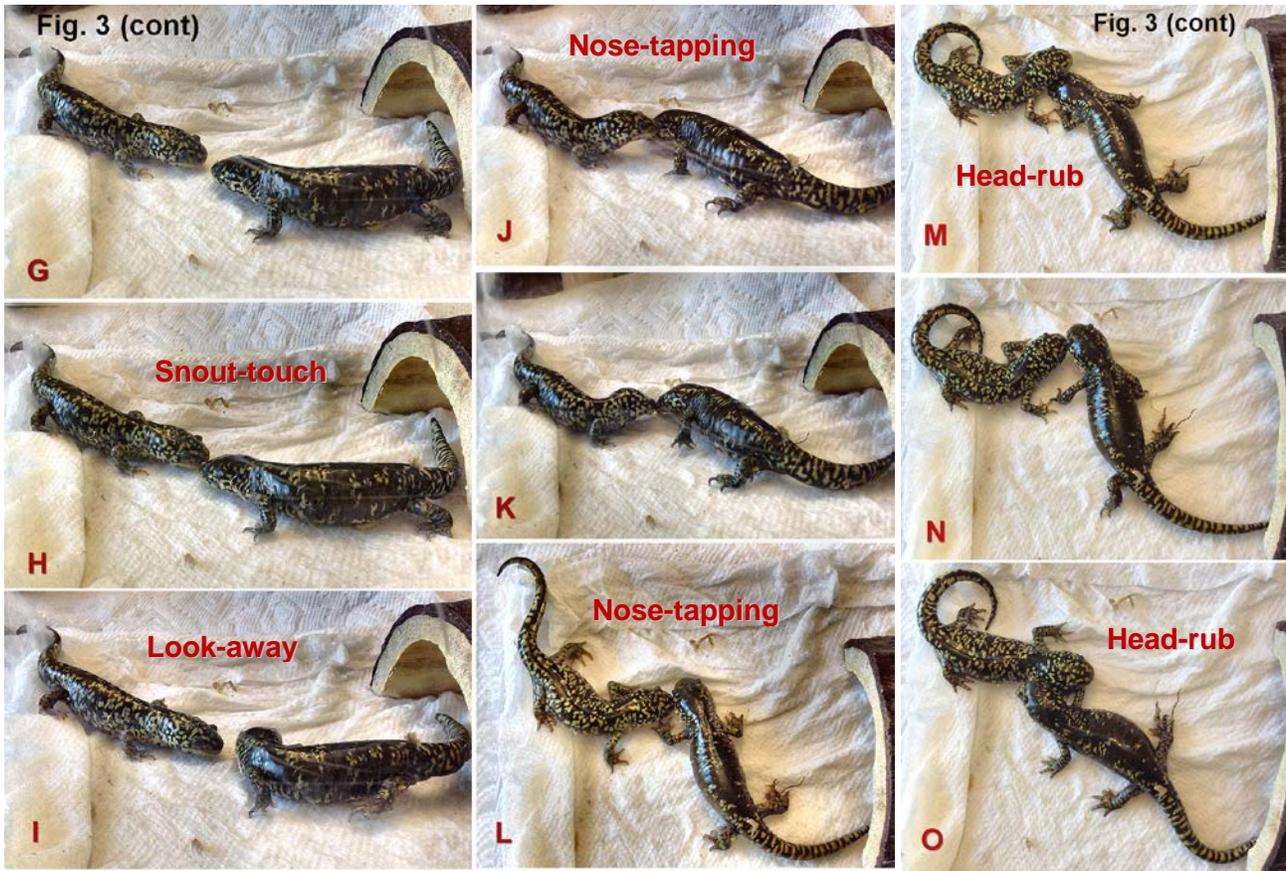


Figure 3 continued: G-O. Two young female barred tiger salamanders continue the sequence of visual gestures as they come together and interact, culminating in a series of head rubs and snout-to-head touches.

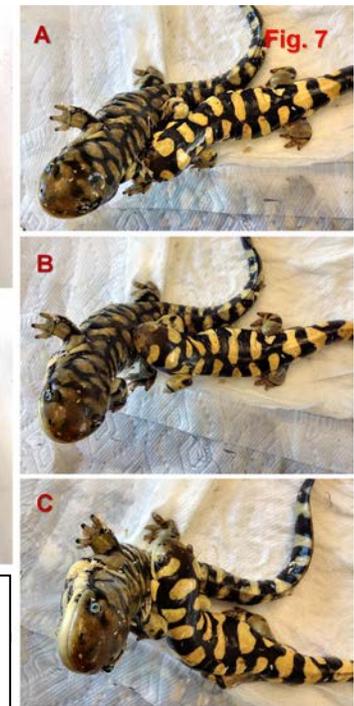
girl (the less marked animal) rubbed her head under the other's head, then pressed her cheek against the side of the other animal's head (enlarged in Figure 2B'). Clock-girl then settled down, leaning on Hamster's back (Figure 2 C,D).



Figure 4. Later interaction of two young western tigers (shown in Fig 2,3) touch snouts and heads. Figure 5. Adult male eastern tiger noses the cheek of one of the young salamanders shown in Fig.5



Figure 6. Adult male eastern tiger greets larger male western tiger. Figure 7. Western tiger (Fig. 6) greets older male western tiger.



Three days later, they were

removed from the terrarium, after food and a rest, and placed on damp paper towels with the shelter from their terrarium. Clock-girl went into the shelter and Hamster wandered around. Clock-girl sat with her head out at the entrance, roughly parallel to Hamster. Then they

both turned toward each other and Hamster approached (Figure 3A-C). Hamster briefly touched her snout to the substrate (Figure 3D,E), which can be a challenge or aggressive (agonistic) gesture in other *Ambystoma* species (Ducey, 1989). Clock-girl exited the shelter and approached and touched snouts (Figure 3F-H). Clock-girl performed a “look away” (Figure 3I), a gesture that is described as placatory/showing lack of hostile intent in *Ambystoma maculatum*, the spotted salamander (Ducey and Ritsema, 1988). Both animals participated in snout and snout/head touching followed (Figure 3I-O). The entire sequence took about 7 minutes. In other sequences of this type, my pet *Ambystoma mavortium nebulosum* tapped much farther down the flank. Some *Ambystoma mavortium mavortium* have performed more mutual head rubbing (gular/chin surface over top of head). Some sequences have been much faster. The full sequence termed the “greeting”, here, occurred only after young metamorphs had acclimated to their terrarium and feeding protocol.

Most of the individual gestures seen are described in the literature on agonistic (aggressive) behavior in *Ambystoma*, and gestures that diffuse aggressive behavior. The species studied are *A. texanum*/smallmouth salamander, *A. opacum*/marbled salamander, *A. tremblayi*/blue spotted salamander, *A. macrodactylum*/long-toed

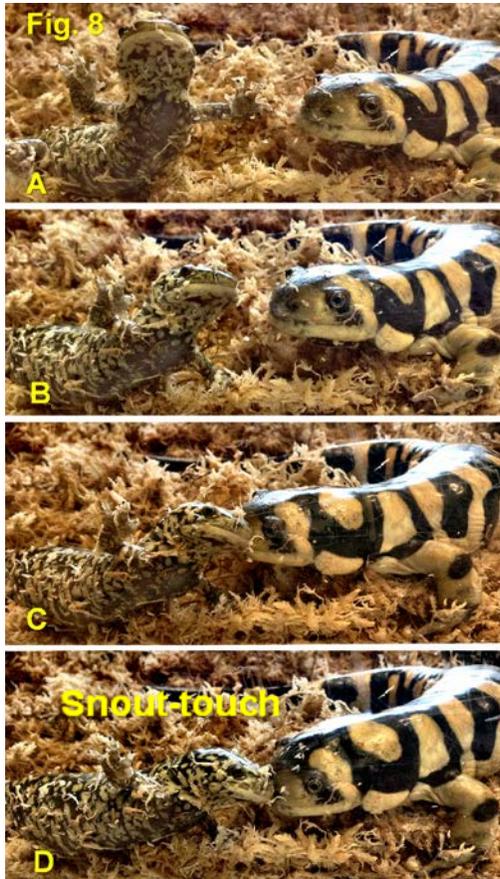


Figure 8. Large adult male western tiger (right) and young female barred tiger lean in and touch snouts.

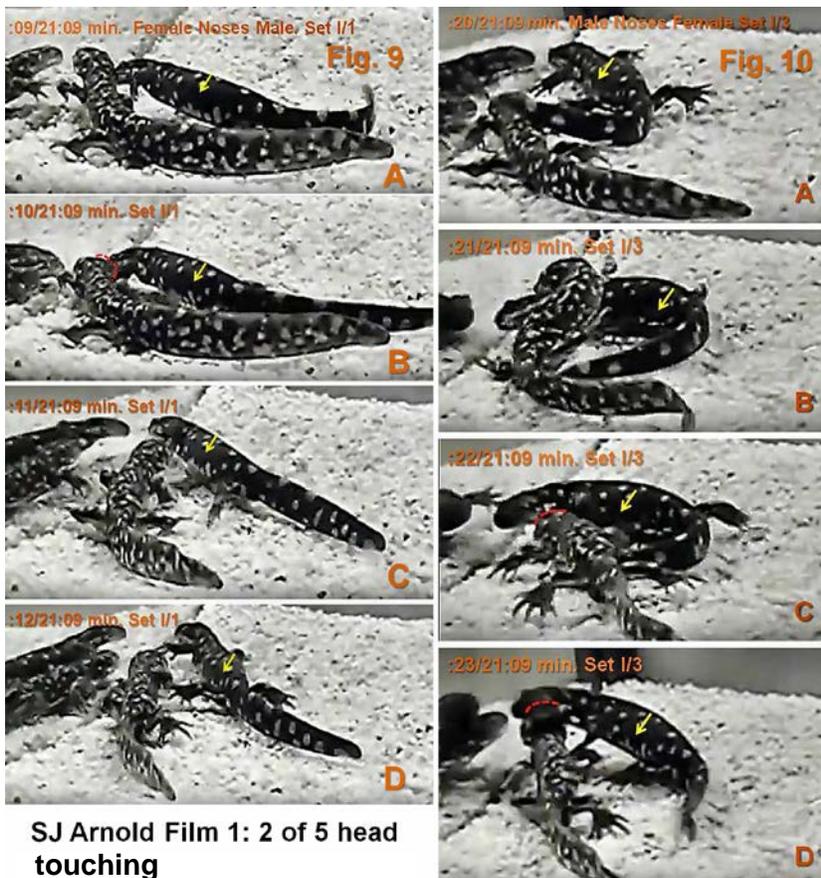
salamander, *A. talpoideum*/mole salamander, *A. maculatum*/spotted salamander (Ducey and Ritsema 1988; Ducey 1989; Walls, 1990; Ducey and Heuer 1991; rev. Mathis et al., 1995; rev. Wells, 2007). Some show aggression toward conspecifics related to territoriality in a laboratory setting, and some species do not. Food abundance strongly reduced biting behavior in *A. maculatum*/spotted salamanders, *A. opacum*/marbled salamanders, *A. talpoideum*/mole salamanders, and *A. tremblayi/jeffersonianum-laterale* hybrids (Ducey and Heuer, 1991). The literature through 1995 is reviewed in Mathis et al., 1995 (*Ambystoma* pp.646-649; Wells, 2007). I could find no description of pressing together at the cheek as shown in Figure 2B, B'. I have had two Western tigers that initially performed an alternate greeting sequence in which they approach, then slowly lean forward to touch snouts, holding that position. The “greeted” salamander would cooperate. Eventually they learned the “normal” head touching and rubbing. A snout touch is shown in Figure 8. Oiva, the large male is one of the tiger salamanders who performs the alternate greeting persistently.

In 20+ years of observing this linking of behaviors into a greeting-like sequence, the sequence does not appear aggressive. I have only seen biting once: a juvenile male Western Tiger (individual in Figure 7, shown there as an adult) bit an adult female Western Tiger on the snout after approaching and nose-tapping her.

With time, the “greeting” becomes a mutual, abbreviated sequence. This is performed when animals emerge from their burrows and meet, and when animals that have been in separate terrariums are reintroduced. Sometimes it involves extensive snout touching, head rubbing, such as a later interaction of the animals shown in Figure 1-3 (Figure 4, 12/26/16, one month after arrival), and head or cheek touching when youngsters are introduced to an older animal (Figure 5, 01/13/17). Most of my animals enjoy soaking, especially near a skin shed, and will often exchange a head-rub between two previously acquainted animals (Figure 6, 7 year old Eastern tiger male from Florida, 8 year old Western tiger male from Florida; Figure 7, Same 8 year old Western tiger male, 15 year old Western Tiger male from Texas).

There is one published example of non-aggressive behavior in tiger salamanders that involves nose-tapping on the snout and head in tiger salamanders, or on the body just behind the head. It occurs under water and is shown as part of the tiger

salamander “mating dance”/courtship behavior. Two excellent *A. tigrinum* courtship sequences from Stevan J. Arnold’s 1969-1970 filmed studies are shown on YouTube: www.youtube.com/watch?v=v59BLSe27Ls and www.youtube.com/watch?v=qcz6R3IVGc4. The animals were eastern tigers from Michigan. This research is described in publications (Arnold 1972, 1976; Houck and Arnold 2003). So nose-tapping between tiger salamanders is has been shown, at least in courtship behavior. It is called “nosing” in the courtship literature which includes the step where the male pushes the female around to remove her from an area with other males. The nosing that resembles part of the “greeting” sequence, however, occurs near the beginning of the filmed interactions, rather than as the climax of the “greeting”. Both the female and the male perform this “nosing” and there are 5-6 such nosings in each film. The courtship sequences from Stevan J Arnold of several other *Ambystoma* species are also shown on YouTube. In *A. mexicanum* (the Axolotl), there is some head nosing very early, though it earns the male a nip at one point. <https://www.youtube.com/watch?v=Mmh4YrmhTQk>.



SJ Arnold Film 1: 2 of 5 head touching

Figure 9-10. Screen captures from SJ Arnold, *A. tigrinum* film 1 via YouTube and Ph.D. Dissertation 1972. In Fig.9 the female noses the head of the male. In Fig.10 the male noses the head of the female.

I have seen head touching without biting in mating axolotls in my laboratory. The head nosing is largely absent in *A. maculatum* (spotted salamander) Arnold lab film. In sequence 3, there is some at 1:44 minutes: https://www.youtube.com/watch?v=QMB36Nu1t_0 At the beginning of *A. maculatum* sequence 2 there is rubbing under the female’s chin and swiping over the head later, rather than head nosing: <https://www.youtube.com/watch?v=nq1CWHLiWBI>. The beginning contact is not as clear in *A. maculatum* sequence 1: <https://www.youtube.com/watch?v=MwvaDbS20c8>. The *A. laterale* (blue spotted salamander) sequence does not show head nosing:

<https://www.youtube.com/watch?v=1hnpKmk48cY>. For *A. texanum* (smallmouth salamander) there is one head-nosing by the male at 10 seconds, with extensive head rubbing later 1:35+min <https://www.youtube.com/watch?v=Q-J635lfuo0>.

There are two other groups of salamander behavioral studies that could have links to greeting behavior: “gregarious” behavior and the neuroendocrine studies of courtship, mating and maternal behavior.

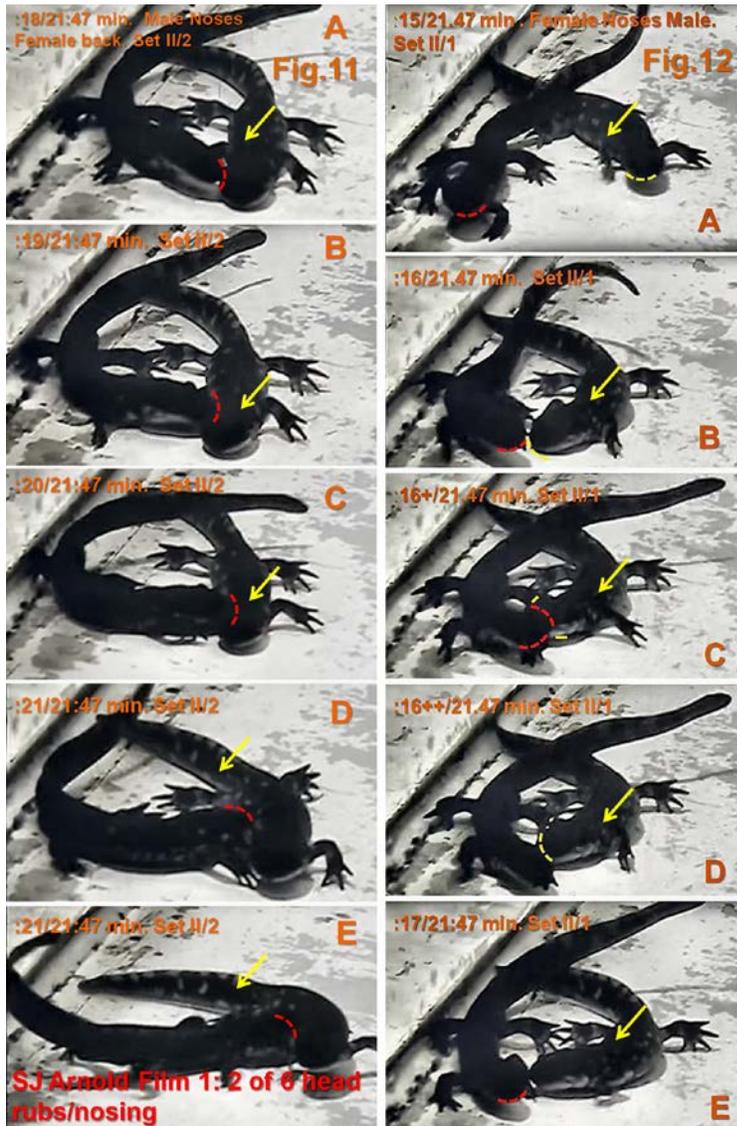


Figure 11-12. Screen captures from SJ Arnold, *A. tigrinum* film 2 via YouTube and Ph.D. Dissertation 1972. In Fig.11 the male noses the head of the female. In Fig.12 the female noses the head of the male.

The phenomenon of animals of the same species grouping together is termed gregarious behavior, as opposed to solitary behavior, and has been documented in European and North American salamanders. Gregarious behavior has an important territorial scent-marking component and it proposed to be a response to harsh conditions such as an arid or frigid environment (Gaultier et al., 2006). Gregarious behavior is thought to have a role in production of group dens for eggs, in *Batrachoseps gregarius* (Jockusch et al., 1998). In the red-backed salamander, *Plethodon cinereus*, small groups (2-7) have been described under natural cover (Jaeger, 1979). In the summer, outside of courtship, season one third of *P. cinereus* have been documented to be in male-female pairs (Gillette et al., 2000), a phenomenon termed “social monogamy”. Social monogamy represents a limited form a gregarious behavior.

Burrow co-occupancy in laboratory and field settings for the spotted salamander, *A. maculatum* represents a form of gregarious behavior in Ambystomatids (Regosin et al., 2004) and field studies show shelter co-occupancy for *Salamandra salamandra* Leeb et

2004) and field studies show shelter co-occupancy for

al., 2013). Co-denning of tiger salamanders with each other and with small mammals has been summarized in another paper (Chernoff, 2016).

Outside of studies of the role thyroid hormone in amphibian metamorphosis, courtship and maternal behavior in salamanders are the best investigated examples of hormonally-regulated salamander social behavior and interactions (rev: Wilczynski et al., 2005; Moore et al., 2005; Nussbaum, 1985; Boyd 2012; Oneto et al., 2014). This works in both directions: social behavior also affects/reinforces the neuroendocrine response (Wilczynski et al., 2005). Neuroendocrine studies show the involvement of “sex hormones” (estrogens and androgens) as well as “stress hormones” (corticosterone) and the peptide (short protein) neuroactive molecules arginine vasotocin (AVT) and mesotocin (MT), which acts in place of the mammalian neuropeptides arginine vasopressin (AVP) and oxytocin (OT) in promoting social interaction (rev. Wilczynski et al., 2005; Moore et al., 2005; Searcy et al., 2009; Wilczynski et al., 2017). AVT affects both male and female salamanders in courtship. The nerve fiber connections of AVT-containing salamander neurons are heavy in areas of the brain affecting social behavior and decision making (Wilczynski, et al., 2017). It has been suggested that AVT and other vasoactive peptides can have species specific effects on behavior from studies in fish and in birds (Goodson 2005), so there may be differences among salamander species. It is very hard not to anticipate that there is a neurobiology of gregarious behavior in the brain of the tiger salamander, perhaps linked to the AVT/MT, system. And, perhaps, this could explain friendly intra- and inter-species behavior in tiger salamanders.

In summary, there are many descriptions of agonistic interactions in *Ambystoma* species other than tiger salamanders, with postures interpreted as dominant, submissive and placatory (Ducey, 1989; rev. in Chernoff, 2000). It is known that juvenile *Ambystomatids* are more likely to run than bite compared with adults and that abundant food reduces agonistic interactions (Ducey, 1989b; Ducey and Heuer, 1991). Some of these reported postures, such as “head butted to the substrate” and the “look-away/turn-away”, are shown in the full tiger salamander “greeting” sequence shown in Figure 3. The full and abbreviated “greeting” interactions described here use gestures and visual displays described in other *Ambystoma* species, but in a sequence that is part of a peaceful interaction, rather than ending in biting or running away. The nose-tapping and head rubbing at the climax of the sequence is what is previously undescribed. In addition, the head/snout touching of the “greeting” sequence is seen at the beginning of the courtship sequence, so it is not a totally unknown gesture in tiger salamander interactions. It is not known whether general lack of biting/aggressive behavior between captive tiger salamanders results from moderation of agonistic behavior in the presence of abundant food, or exists in nature. In captive animals, this behavior occurs in fragmented form in newly arrived juveniles and in full form as they acclimate. With time, the adults develop an abbreviated version of the display/gestures upon meeting. It is as though they progress from “Hi, I’m upset” to “Hello, I am _____, who are you? Do you live here?” to “Hi there, me again”. There is a huge neurobiological gap between understanding of regulation of courtship/mating behavior and other types of social interactions in salamanders. A first step in understanding the

behavior reported here would be determining the extent to which tiger salamanders perform a formal “greeting” sequence when meeting: how widespread is it in different tiger species and subspecies? Is it age/maturity-linked? Is it more common between animals from the same/related or neighboring populations? How uniform are the steps in different groups?

BIBLIOGRAPHY (with free full-text links, where available)

- Arnold SJ (1972) The evolution of courtship behavior in salamanders. Ph.D. Dissertation. University of Michigan. 570p.
- Arnold, S.J., 1976. Sexual behavior, sexual interference and sexual defense in the salamanders *Ambystoma maculatum*, *Ambystoma tigrinum*, and *Plethodon jordani*. *Zeitschrift für Tierpsychologie*. 42: 247-300. http://people.oregonstate.edu/~arnoldst/pdf_files/Arnold%201976.pdf
- Boyd, S.K. (2012) Vasotocin modulation of social behaviors in amphibians. Chapter 7 in: *Oxytocin, Vasopressin and Related Peptides in the Regulation of Behavior*, edited by E. Choleris, D. Pfaff and M. Kavaliers, Cambridge University Press. <http://sites.nd.edu/sunnyboyd/files/2011/09/PreReleaseDraft.pdf>
- Chernoff, EAG (1999b) Taming your adult tiger salamander: use their behavior as a guide. *Reptile & Amphibian Hobbyist* #42 4(12): 56-59. https://www.researchgate.net/publication/309352444_Taming_your_adult_tiger_salamander_Use_their_behavior_as_a_guide
- Chernoff, EAG (2000) Where does tame *Ambystomatid* salamander behavior come from? What is normal behavior? A look at the literature. *Reptile and Amphibian Hobbyist* #50 5(8):49-55 https://www.researchgate.net/publication/309352062_Where_does_tame_ambystomatid_salamander_behavior_come_from_What_is_normal_behavior_A_look_at_the_literature
- Chernoff EAG (2016) How smart and how social is my tiger salamander. *Caudata Culture* article for *Caudata.org* (Newt and Salamander Portal), a site for salamander keepers, scientists https://www.caudata.org/cc/articles/tiger_salamander_behavior.pdf
- Chernoff EA, Macke J (2017) Tiger Salamanders and Mammals: Underground Companions? PEEC (Pajarito Environmental Education Center) at the Los Alamos Nature Center. *Nature News* October 2017 newsletter and online <https://peecnature.org/salamanders/>
- Ducey, PK and Ritsema, P. (1988) Intraspecific aggression and responses to marked substrates in *Ambystoma maculatum*. *Copeia* 4:1008-1015.
- Ducey, PK (1989) Agonistic behavior and biting during intraspecific encounters in *Ambystoma* salamanders. *Herpetologica* 45:155-160.
- Ducey PK, Heuer J (1991) Effects of food availability on intraspecific aggression in salamanders of the genus *Ambystoma*. *Can J Zool* 69:288-290.
- Gehlbach FR, Kimmel JR, Weems WA. (1969) Aggregations and body water relations in tiger salamanders (*Ambystoma tigrinum*) from the Grand Canyon rims, Arizona. *Physiol. Zool.* 42:173-182

- Gillette JR, Jaeger RG, Peterson MG (2000) Social monogamy in a territorial salamander. *Anim Behav* 59:1241-125.
- Goodson JL (2005) The vertebrate social behavior network: evolutionary themes and variations. *Horm Behav.* 48:11–22. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2570781/>
- Houck, L. D. and S. J. Arnold. 2003. Courtship and mating behavior. Pp. 383-424 IN: D. Sever (ed.), *Reproductive Biology and Phylogeny of Urodela*. Chapter 10. Science Publications, Endfield, NH. vol 1 of series: *Reproductive Biology and Phylogeny*. Ed by Barrie G.M. Jamieson. <http://www.cnah.org/pdf/88410.pdf>
- Jaeger RJ (1979) Seasonal spatial distributions of the terrestrial salamander *Plethodon cinereus*. *Herpetologica* 35:90-93
- Jockusch EL, Wake DB, Yanev KP (1998) New species of slender salamanders, *Batrachoseps* (Amphibia: Plethodontidae), from the Sierra Nevada of California. *Serial Pub Nat Hist Museum Los Angeles County*, 472. https://nhm.org/site/sites/default/files/pdf/contrib_science/CS472.pdf
- Leeb C, Hödl W, Ringler M. (2013) A high-quality, self-assembled camera trapping system for the study of terrestrial poikilotherms tested on the Fire Salamander. *Herpetozoa* 25(3-4):151-153 https://www.researchgate.net/publication/258227562_A_high-quality_self-assembled_camera_trapping_system_for_the_study_of_terrestrial_poikilotherms_tested_on_the_Fire_Salamander
- Mathis A, Jaeger RG, Keen WH, Ducey PK, Walls SC, Buchanan BW. Aggression and territoriality by salamanders and a comparison with the territorial behavior of frogs (1995) In: “*Amphibian Biology*” vol. 2 *Social Behavior*: ed. by H Heatwole and BK Sullivan. Chipping Norton, NSW, Australia. pp. 633-676. https://www.researchgate.net/publication/279712614_Aggression_and_Territoriality_by_Salamanders_and_a_Comparison_with_the_Territorial_Behavior_of_Frogs_Amphibian_Biology
- Moore FL, Boyd SK, Kelley DB. (2005) Historical perspective: hormonal regulation of behaviors in amphibians. *Horm Behav* 48:373–83. doi:10.1016/j.yhbeh.2005.05.01
- Nussbaum RA (1985) *The Evolution of Parental Care in Salamanders*. Miscellaneous Publications Museum of Zoology, University of Michigan. No. 169. 60 p. https://www.researchgate.net/publication/30857144_Evolution_of_parental_care_in_salamanders
- Oneto F, Ottonello D, Pastorino DV, Salvidio S (2014) Maternal care and defence of young by the plethodontid salamander *Speleomantes strinatii* (Aellen, 1951). *Scripta Herpetologica*. Studies on Amphibians and Reptiles in honour of Benedetto Lanza: pp. 129-136. https://www.researchgate.net/publication/262916268_Maternal_care_and_defence_of_young_by_the_plethodontid_salamander_Speleomantes_strinatii_Aellen_1951
- Regosin JV, Windmiller BS, Reed JM (2004) Effects of Conspecifics on the Burrow Occupancy Behavior of Spotted Salamanders (*Ambystoma maculatum*). *Copeia*, 2004(1):152-158
- Searcy BT, Walther EA, Heppner BL, Thompson RR, Moore FL (2009) Identification of mesotocin and vasotocin nucleotide sequences in two species of urodele amphibian. *Gen and Compar Endocrinology* 160:111–116
- Titus V, Madison D, Green T (2014) The importance of maintaining upland forest habitat

surrounding salamander breeding ponds: case study of the eastern tiger salamander in New York, USA. *Forests* 5:3070-3086. <https://www.mdpi.com/1999-4907/5/12/3070>

•Walls SC (1990) Interference competition in postmetamorphic salamanders: interspecific differences in aggression by coexisting species. *Ecology* 71: 307-314.

•Wells KD (2007) Communication and social behavior of urodeles and caecilians. In: "The Ecology and Behavior of Amphibians" University of Chicago Press. Chicago, IL USA. Ch. 9, pp. 403-450. https://books.google.com/books?id=eDKEKy5JJbIC&printsec=frontcover&source=gbs_ge_summary_r&cad=0#v=onepage&q&f=false

•Wilczynski W, Lynch KS, O'Bryant EL. Current research in amphibians: studies integrating endocrinology, behavior, and neurobiology. *Horm Behav* 48:440–50. doi:10.1016/j.yhbeh.2005.06.001

•Wilczynski W, Quispe M, Muñoz MI, Penna M (2017) Arginine vasotocin, the social neuropeptide of amphibians and reptiles. *Front Endocrinol* 8: article186. 17 pages doi: 10.3389/fendo.2017.00186 <https://www.frontiersin.org/articles/10.3389/fendo.2017.00186/full>

Co-denning photos from Caudata.org and field herp forum

Daniel, pack of tiger salamanders:

<https://www.caudata.org/photoplog/index.php?n=493>

[Tiger mom Tammy](#) Two tigers co-denning:

<https://www.caudata.org/forum/album.php?albumid=4472>

[frogman](#) two denning

<https://www.caudata.org/forum/album.php?albumid=3321>

Eastern tigers found, revealed under cover; 2 with a snake (Field Herp Forum 2011 author "Wild Child Luxy) <http://www.fieldherpforum.com/forum/viewtopic.php?t=5744&p=68717>

[henslowsparrow](#)

Three eastern tigers

<https://www.caudata.org/forum/album.php?albumid=775&pictureid=7398>

Interacting from Caudata.org

[KingCam](#) 2 tigers interacting

<https://www.caudata.org/forum/album.php?albumid=2479&pictureid=21187>

[saglines](#) Two tigers interacting: 3 images

<https://www.caudata.org/forum/album.php?albumid=2885>