

# MAKING TOO MANY MISTAKES: CASES OF ABNORMAL AMPLEXI IN EUROPEAN ANURANS

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## Introduction

Animal communication is of crucial importance in order to prevent mistakes during the sexual behaviour and every species has its own mechanisms of reproductive isolation which should prevent mating with another species (Mayr, 1970). Generally, more advanced species have pre-mating isolating mechanisms – behavioural isolation due to more advanced communication. Birds communicate using primarily visual and auditory signals, while mammals additionally have strong developed olfactory methods of communication (Bradbury & Vehrencamp, 2011). Among amphibians, anurans have most developed methods of communication including acoustic signals as primary mode of communication (Witt & Caldwell, 2009).

Sexual behaviour varies greatly among anurans species but the general rule is: the males call to attract females during the breeding season, followed by capturing the female and by external fertilization and the separation of the couple. In most anurans, the male grasps a female with his front legs so that his cloaca is positioned above the female's cloaca. This mating behaviour is called **amplexus** and it is followed by external fertilization of eggs. Amplexus is a phenomenon which usually occurs in the water ("aquatic made amplexus"). Males arrive earlier at the waterbodies and stay longer there than females do (Davies & Halliday 1979). Male frogs often mount heterospecific female frogs trying to grasp the largest individuals among the available females. However, some species already form couples on land followed by united migrating towards the water ("terrestrial made amplexus"; Duellman & Trueb 1986; Schmeller et al. 2005; Vitt & Caldwell 2009). According to the Witt & Caldwell (2009) several types of amplexi were described so far, while in European anurans are known two: (1) axillary (families Bombinatoridae, Pelobatidae and Pelodytidae) and (2) inguinal (all other European anuran families).

Reproductive behaviour of anurans can be divided in two basic patterns: (1) prolonged breeding that may last several months in temperate climates to all year in the tropics (Duellman & Trueb, 1986) and (2) explosive breeding that is characterized by males remaining at breeding sites for only a few days, chorus formation, and synchronous arrival of the female in the pond and low selectivity of the males (Wells, 1977, 2007; Izzo, 2012).

Frogs and toads use **four types of signals** for species and sex recognition: (1) vocal (auditory), (2) visual, (3) tactile and (4) chemical (Wells, 2007; Bowcock et al., 2008; Belanger and Corkum, 2009; Vitt & Caldwell, 2009). They often use tactile cues to distinguish gender, particularly in explosively breeding species. The larger body of a gravid female provides the tactile cue that identifies her gender and reproductive state to a male. In prolonged-breeding species, a female approaches a calling male, and typically, the male continues to call until touched or nudged by the female. To discourage wrong amplexi, male and non-receptive female anurans can use specialized signals, such as release calls and characteristic body vibrations or inflating (Bowcock et al., 2008; Bruning et al., 2010; Mollov et al., 2010; Izzo et al., 2012).

## Materials & Methods

Herein we present 65 cases of unusual amplexi of some European anuran species unintentionally observed on random fieldwork activities. To detect which species makes the most mistakes we made charts in Excel table in which we presented the number of every species and taxon that created erroneous amplexi. We assessed the number individuals for each species that had made a mistake (named "upper species") as well as for those who suffer from error (named "bottom species") (Fig. 1).

Some species from the same genus (e.g. *Bombina*, *Pelophylax*) are well known to make huge hybrid zones (Vitt & Caldwell, 2009) so amplexi between them are not taken into consideration with the assumption that they are very common. Mating balls composed of individuals of the same species (*Bufo bufo*) are also neglected in this paper due to the assumption that very common phenomenon consciously carried out by males through the process of competition. In other multiple amplexi, all individuals in the middle are recorded as one individual and they were marked both as "upper" and "bottom" species.

## Results & Discussion

We observed numerous types of abnormal amplexi, so we unconditionally divided them into 11 groups. European Amphibian taxa involvement in erroneous amplexuses according to the field investigations and literature data can be generally divided into intraspecific or interspecific and furthermore as (i) **heterosexual** (male with non-pregnant female), (ii) **homosexual** (male with male), (iii) **pedosexual** (male with sexually immature, juvenile individuals or eggs), (iv) **necrosexual** (with dead individuals), (v) **obosexual** (with inanimate objects), (vi) **group** (mating balls with more than two individuals or) (vii) **combined**. Erroneous amplexi in European taxa can also include variable positions like abdominal, lateral, semiaxillary, semiinguinal etc.

For now, we can say that at least **16 European species of anurans are known to make wrong amplexi** (and also taking damage from), while at least 19 species are taking damage. Anuran species that have only been observed as bottom species are: *Rana graeca*, *Pelophylax perezi* and *P. ridibundus*. *Rana graeca* lives mostly in cold streams or rivers (Lymberakis et al., 2009), so encounters with other amphibian species are rare since amphibians mostly requires stagnant types of water (Vitt & Caldwell, 2009). *Pelophylax perezi* and *P. ridibundus* are well known to make fertile hybrids so these are not taken into the consideration as wrong or unusual amplexuses. However, we expected lot of wrong amplexuses from *Pelophylax* species since they live in various types of habitat, lives in sympatry with other amphibian species and has a wide distribution across the Europe. Small percentage of mistakes we attributed to the fact that *Pelophylax* are a prolonged-breeding species, with a female that will approaches only to a calling male. Such lekking behaviour is also known to *Hyla* species (Friedl & Klump, 2002) and they also make a very small part in the wrong amplexi.

The most common species in the abnormal amplexi is *Bufo bufo*. The reasons are the following: (1) it has widest distributed in Europe of all anuran species, (2) it is common species – population with a large number of individuals (Agasyan et al. 2009), (3) there are extremely explosive breeders, (4) they are no or low rates for sexual selection – males of all sizes showed capability of fertilizing all eggs of any female (Wells, 1977). After *B. bufo* the most common mistakes are made by *Bombina variegata*, following by *Rana temporaria* and *Rana dalmatina* which are also very common and widely distributed species through Europe. Unlike the other mentioned species, *Bombina variegata* is not an explosive breeder. It usually lives in very small and shallow ponds (Kuzmin et al., 2009) where close encounters with other amphibians are regular due to the small habitat size. Probability of making mistakes in behaviour in small habitats or captivity is probably very high (e.g. Malashicev, 1999).

Abnormal amplexi between anurans can act negatively or neutrally. Females suffers no or small damage, but males suffer by wasting time and energy with missing opportunities to mate with own species (Simović et al., 2014). For male anurans, courtship and mating are expensive in terms of energy, time and predation risk (e.g. McCauley et al., 2000; Dordević & Simović, 2014). Smaller males can be also rejected by females or displaced by larger males during fierce fights over females (Arak, 1988; Davies & Halliday, 1979; Lamb, 1984). Due to the interspecific differences in vascularization of respiratory surfaces of amphibian species (Czopek, 1962) some wrong amplexi could be separated relatively swiftly. This could happen in case that the grabbed female which controls the movement of an amplexus is a species that is more adaptive to aquatic habitat. Those females are likely to be released by a male under the water. Some frog species cannot stay long under the water (like *Bombina* species; personal observation). It is known that wrong amplexi can cause death of females by drowning accidentally in multiple amplexi or mating balls (Wells, 2007). Female realising calls sometimes does not have affect (observations F), but can summon predators which can lead to amplexus separating. Amplexus with non-pregnant female (observation F) are probably more common but these observations are not published because unpregnant females are hardly identified in the field during the amplexus. If it comes to ejecting eggs by female during the wrong amplexus males are not able to fertilize them unless the species are closely related. Such eggs perish, or could be used in post-mating clutch piracy (Vieites et al., 2014). Sister group of anuran do not get separated so easily. Because they share similar biology characteristics they hybridize readily giving rise to a hybrid zones. Some of them are strong making fertile hybrids or kleptonic species (e.g. *Pelophylax kl. esculentus*) (Holsbeek & Jooris, 2010) or making a quite common hybrid dysfunction (eg. *Bombina variegata*/*B. bombina*) (Kruuk et al., 1999) or hybrids with high mortality (*Bufo viridis*/*Bufo bufo*) (Duda, 2008). *Salamandra salamandra* are known to suffer being suffocated from explosive breeders because the reproduction time matches the mating season of *Bufo bufo* and *Rana temporaria*.

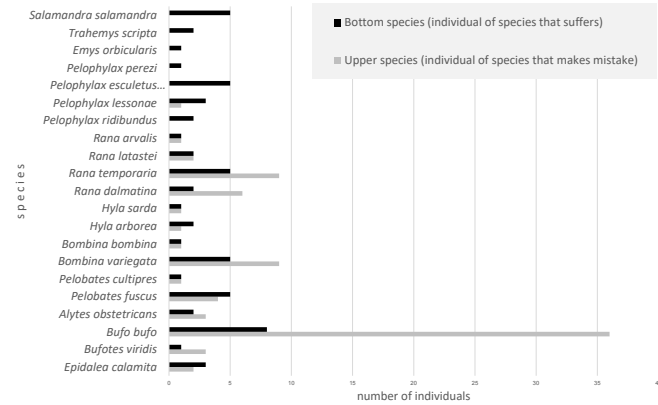


Figure 1. European amphibian taxa involvement in erroneous amplexi



Figure 2. Some of encountered erroneous amplexuses: (a) *Pelobates cultripes* x *Pelophylax perezi* (photo: Herero D.), (b) *Bombina variegata* x *Pelophylax ridibundus* (photo: Zimić A.), (c) *Epidalea calamita* x *Bufo bufo* (photo: Bühler C.), (d) *Bufo bufo* x Ranidae eggs (photo: Martinez, N.), (e) *Pelodytes* multiple amplexus, (f) *Epidalea calamita* x *Pelobates cultripes* (photo: Herero D.), (g) *Bombina variegata* x *Pelodytes* (h) *Bufo bufo* multiple amplexus x *Rana temporaria* (photo: Bonk M.), (i) *Bufoles viridis* x *Bufo bufo* (Kolanek A.), (k) *B. bufo* multiple x *Pelophylax kl. esculentus* (photo: Bonk M.), (l) *Rana temporaria* x *Pelobates fuscus* (photo: Bonk M.), (m) *Pelobates fuscus* x *Hyla arborea* (n) *Rana arvalis* x *Pelobates fuscus* (photo: Laskowski P.) (o) *Bombina variegata* x *Bufo bufo* (photo: Martinez, N.) and (p) *Rana temporaria* x *Pelobates fuscus* (photo: Laskowski P.)



Figure 3. *Bufo bufo* group amplexus with *Trachemys scripta* (a). As a result of this wrong amplexus many individuals are being „trapped inside turtle shell“, suffocated, fractured and killed (b) (photo: Jelić L.)



Figure 4. *Bufo bufo* group amplexus with *Salamandra salamandra* in an attempt not to drown (a) and *B. bufo* group amplexus with drown female (b) (photo: Jelić L.)

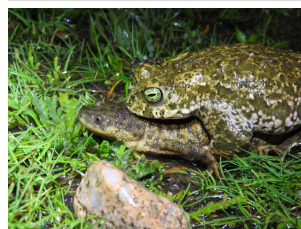


Fig 5. *Epidalea calamita* x *Pleurodeles waltl* (photo: Pedro V.D.)