Sound production in *Calliptamus barbarus* Costa 1836 (Orthoptera: Acrididae: Catantopinae)

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**Abstract.** *Calliptamus barbarus* Costa 1836 is an acridid species whose hind femora display chromatic polymorphism that may be of ruby colour with three bold and separate femoral spots, or pale orange, with only one large femoral spot. Since both bio forms (either with three (3S) or with one (1S) spot) appear to be segregated, and their sounds constitute an intra-specific recognition system during mating, the sounds emitted by both groups were studied in order to identify any differences between them. It was observed that the sound is produced by mandible friction in both males and females. The temporal characteristics of the acoustic emissions of the males of both bio forms showed significant differences under all conditions. In females, some differences in frequency and in temporal characteristics were also detected. Likewise males, the syllable length and the number of emitted pulses are greater in the 1S than in the 3S form. Together with other differences, these observations suggest a true separation between these bio forms, with a reproductive isolation that will probably lead to a speciation process.

**Résumé.** Production de son chez *Calliptamus barbarus* Costa 1836 (Orthoptera : Acrididae : Catantopinae). *Calliptamus barbarus* Costa 1836 est un acridien qui présente un polymorphisme chromatique au niveau des fémurs postérieurs. Ces derniers peuvent être d’une couleur rouge rubis, avec des taches fémorales séparées et bien marquées, ou d’une couleur orange pâle, avec une seule et grande tache fémorale. Les deux formes peuvent être facilement séparées. Les sons constituent un système de reconnaissance intraspécifique durant l’accouplement, nous avons étudié les sons produits par les deux formes pour y détecter d’éventuelles différences. Le système de production du son par friction mandibulaire, chez les mâles comme chez les femelles, a été étudié. Les caractéristiques temporelles des émissions acoustiques des mâles des deux formes présentent des différences significatives dans toutes les situations étudiées. Certaines différences ont également été détectées chez les femelles. Pour les mâles, la durée des syllabes ainsi que le nombre des impulsions émises sont plus grands dans la forme à une tache fémorale (1S) que dans la forme à trois taches (3S). Ces faits, ajoutés à d’autres différences, suggèrent une réelle séparation, avec un isolement reproductif entre les deux formes qui pourrait conduire à un processus de spéciation.

**Keywords:** Grasshoppers, polymorphism, acoustic differentiation, speciation, bio forms.

The sounds produced by Orthopterans are of great taxonomic value. They play a well known role as identification system during mating, and for this reason they are of great value for establishing the real status of local populations that display small morphological differences (Blondheim 1990, García *et al.* 1996).

*Calliptamus barbarus* Costa 1836 is an Acridid widely distributed throughout the countries of the Mediterranean basin and their islands, reaching Southern Siberia, Mongolia, China, Afghanistan and West Pakistan. In Spain it is found almost throughout the mainland territory. This species shows a very marked chromatic polymorphism, and two bio forms can be differentiated by the colour of the inner side of the hind femora. In one bio form, the inner side of the hind femora is a ruby colour and has three, more or less separated black spots. In the other bio form, the inner side of the hind femora is pale orange in colour and has one large black spot. Although Jago (1963) suggested that chromatic polymorphism is closely related to geographical distribution in *C. barbarus*, Clemente *et al.* (1987) stated that both bio forms can share particular areas but, in general, they are not usually found in the same places. In the case of *C. barbarus*, the one spot (1S) bio form prefers more insolated places than the three spot (3S) form. The same authors found significant biometric differences between both bio forms, with the 1S individuals being larger than their 3S counterparts. Thus, these authors considered the possibility that both forms might be leading towards reproductive isolation. This idea is
based on the fact that among external reproductive isolation mechanisms (precopula or prezygotic isolation), which probably involve mate recognition, some concern intrinsic population characteristics, such as morphology and behaviour. Among orthopterans, behaviour and communication characteristics are increasingly being considered as important mechanisms of prezygotic isolation.

Concerning the behaviour and communication in genus *Calliptamus*, Uvarov (1977) indicated that, before approaching a female, the males move around her emitting short songs produced by the mandibles, and performing movements with the hind femora, although their significance are not clear. In the genus, the few behavioural studies that exist have focused on the species *Calliptamus italicus* (L. 1758). In this species, Faber (1953) showed that sound production in the form of ordinary song, courtship song or disturbance song, is due to mandibular friction, and can be accompanied by convulsive movements of hind femora. As for the species *Calliptamus barbarus*, only one study exists on its behaviour in captivity (Larrosa et al. 2004), but there are not studies on its sound production.

Because of all above concerns about the homogeneity of this species, in particular its morphological and biometric features, and because of lack of knowledge on its communicative activity, we considered of great interest to study the communication patterns of both bio forms (1S and 3S) of *C. barbarus*. Such a study will contribute to our knowledge of the biology of the species and will help to establish whether both bio forms are involved in a reproductive isolation process.

**Material and Methods**

Table 1 summarizes the collecting data of the specimens used in the study.

The specimens were collected by entomological net, placed in cages containing natural vegetation and transported to the laboratory, where they were kept in wooden cages, separated by sex and bio form, and watered daily. They were mainly fed lettuce and bread. The wooden cages had a glass front and a metallic mesh top. They measured 40 × 30 × 40 cm, and were lit 12 hours per day by a 25 W bulb.

All observations and sound recordings were made in a soundproof room, at the Faculty of Biology, in the University of Murcia. For this purpose, the specimens were placed in a wooden cage of similar design to the holding cages but measuring 32 × 42 × 32 cm. Two adjustable table lamps were used, behind, and above the cage, in order to provide light and heat to the specimens. Ambient temperature inside the cages varied between 34 and 36 °C.

Sounds were recorded with a Tascam DA-P1 analogical recorder attached to an AVL microphone, which was placed inside the cage.

Sound was studied with a Mingograph 420 system attached to a digital oscilloscope (Tektronix 2211) and to a Krohn-Hite 3550 filter. To study the physical characteristics of the sound, the analogical signal was digitized with a Sound Blaster® Audio PCI with Advanced Processor Upgrade, and then studied using the Avisoft® SAS Lab Pro 3.8.

The sounds produced by both sexes and bio forms were recorded under the conditions summarized in Table 2.

To determine whether the sound produced by males had the same characteristics under all conditions, the study identified the sounds according to the context in which they were produced. In the case of the female’s song, the number of registered

### Table 1. Data collection of the specimens used in the study.

<table>
<thead>
<tr>
<th>Bio form</th>
<th>Collecting locality</th>
<th>Altitude</th>
<th>Environment</th>
<th>Collecting date</th>
<th>Specimens</th>
</tr>
</thead>
<tbody>
<tr>
<td>3S (3 femoral spots)</td>
<td>Sierra de la Muela (Murcia)</td>
<td>520 m</td>
<td>High sparse shrubs</td>
<td>9.IX.1998</td>
<td>2 males 3 females</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>26.IX.1999</td>
<td>5 males 8 females</td>
</tr>
<tr>
<td>1S (1 femoral spot)</td>
<td>Casa de las Labores. Sierra Espuña (Murcia)</td>
<td>1130 m</td>
<td>Low dry land pastures</td>
<td>27.VII.1999</td>
<td>7 males 5 females</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>9.IX.1999</td>
<td>6 males 10 females</td>
</tr>
</tbody>
</table>

### Table 2. Conditions under which recordings and observations were made. The specimen which behaviour was studied is indicated in bold.

<table>
<thead>
<tr>
<th>Male 3M</th>
<th>Female 3M</th>
<th>Male 1M</th>
<th>Female 1M</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male 3M</td>
<td>Male 3M-Male 3M</td>
<td>Male 3M-Female 3M</td>
<td>Male 1M-Male 1M</td>
</tr>
<tr>
<td>Male 1M</td>
<td>Male 1M-Female 1M</td>
<td>Male 1M-Female 1M</td>
<td>Female 3M-Female 3M</td>
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<td>Female 3M</td>
<td>Male 3M-Female 3M</td>
<td>Female 3M-Female 3M</td>
<td>Male 1M-Female 1M</td>
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<td>Female 1M</td>
<td>Male 1M-Female 1M</td>
<td>Female 1M-Female 1M</td>
<td>Male 1M-Female 1M</td>
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</table>
songs was much lower than that of males. Because no apparent differences were observed in the recordings, the female study considered all sounds, regardless of the conditions.

The terminology used to describe the acoustic signals is the following:

Song: Acoustic output of a particular species or individual (Ragge & Reynolds 1998).

Syllable: sound produced during a complete cycle of movement of the stridulatory apparatus or the sound producing apparatus (Ragge & Reynolds 1998).

Pulse: simple and homogeneous group of oscillations delimited by silent intervals (Chavasse et al. 1954).

Chorus song: songs produced alternately by a group of males (Ewing 1989).

Courtship song: song produced by a male when next to a female (Ragge & Reynolds 1998).

Interaction song: sound produced by a specimen as a consequence of apparent perturbation generally due to other specimens walking nearby (García et al. 2001).

Thirty (30) songs were selected from each sex and bio form for statistical analysis.

Since previous studies in different acridid species have shown that the most important characteristics involved in song recognition are the frequency and temporal structure of both whole song and syllables (Skovmand & Pedersen 1978, 1983, von Helversen & von Helversen 1983, Eiriksson 1993), the comparative study of the songs of different specimens under different conditions concerned the following parameters: number of pulses per syllable, syllable length, sound frequency, and sometimes, number of pulses per time unit. Silences between pulses and syllables were also considered.

For the statistical analysis and comparison, the statistical analysis software SPSS 10 was used.

The specimens studied, as well as the sound records are kept in the Área de Zoología of the Universidad de Murcia. Sample songs are available at OSF (http://osf2.orthoptera.org) (Eades 2001).

Results

Acoustic emission was usually accompanied by a convulsive movement of the hind femora, and produced by mandibular friction (Larrosa et al. 2004) although it is possible that these movements could also suggest a femur-tegmen sound production pattern. To eliminate this possibility, several experiments were carried out in which the tegmens of the animals were removed or the hind legs had been immobilised. In all cases, sounds of similar characteristics were recorded. In addition, sound was occasionally recorded in non-manipulated specimens even though there was not movement of their hind legs. Thus, sound production coincides with the mandibular friction method described in C. italicus (Faber 1953; Orte 1970; Uvarov 1977).

Sound production was observed and registered under different conditions. In the males of both bio forms, sound production was observed during agonistic interactions between them (interaction song) and when, while pursuing a female (courtship song), the female started to perform movements with the hind femora or to produce a sound.

It was also observed that when three or more males were introduced in the recording cage, sounds were alternately emitted in a chorus song, even thought there was no attempt to approach each other or there was any other apparent interaction.

In females, sound production was observed during interaction between them and when they were being pursued by a male (interaction song). In both cases the 1S females sang more frequently than the 3S females. Nevertheless, although acoustic communication in females was infrequent and provoked a random response, song emission was the behavioral unit that caused a higher percentage of response in the other specimens (Larrosa et al. 2004).

No acoustic emission was observed or registered when the specimens were completely isolated.

Songs description

Males 3S

In the presence of males 3S (Interaction and chorus song)

The sound produced is a variable group of 1–3 syllables, 357 ± 80 ms in total length. The silence between syllables is 150.8 ms (100–261). (fig. 1). Syllables are 71.8 ms in mean length and contain a mean of 6 pulses (3–10). Syllable duration is related to the number of pulses (Pearson’s correlation coefficient = 0.72). Silence between pulses has a mean of 14.9 ms (3.4–39.7).

The syllables are usually composed of pulses that, at the beginning, are of low intensity. Intensity increases until it reaches a maximum in the central pulses and then decreases towards the end. The final pulses are less separated than the initial ones (fig. 2). On a few occasions the syllables start with intense pulses that decrease towards the end (fig. 3), or vice-versa.

The frequency spectrum shows a main peak at around 7700 Hz, with harmonics of higher frequency between 14000 and 19000 Hz (fig. 4). The lower quartile is around 6600 Hz, the medium quartile around 9000 Hz and the higher quartile around 14500 Hz.

The sound is emitted at the same time that the hind femora produces a convulsive movement. Since this movement is very quick and is accompanied by sound, it presumably causes an intimidating visual
and acoustic effect that warns others of the animal’s presence. As suggested by Larrosa et al. (2004), it is therefore logical to expect that the above behaviour is of great importance during the meeting of males.

**In the presence of females 3S (Courtship song)**

The males produce a sound $430 \pm 60$ ms in length, composed of 1–3 syllables. The silence between syllables is $181$ ms (140.3–246.7) (fig. 5). Syllables have a mean length of $101$ ms (44.7–171.1), and are composed of 9 pulses (3–22) which are not uniformly distributed since they appear more frequently in the final part of the syllable, with silence between pulses being $12.5$ ms in mean length (1.1–52.4). The Pearson’s correlation coefficient between syllable length and the number of pulses is 0.66. The most frequent syllables are those composed of pulses that decrease in intensity (fig. 6).

The frequency spectrum shows a main peak at around $7500$ Hz, with harmonics of higher frequency between $14000$ and $19000$ Hz (fig. 7). The lower
quartile is around 6700 Hz, the medium quartile around 10000 Hz, and the higher quartile around 15000 Hz.

The sound is emitted during encounters between males and females after episodes of visual communication involving movements of the hind femora (initiated by the female and followed by the male). If the female continues performing these movements, the male may initiate convulsive movements with its hind femora, accompanied by described acoustic emissions (Larrosa et al. 2004).

Males 1S

In the presence of males 1S (Interaction and chorus song)

The sound produced is a group of 1–5 syllables, 612 ± 282 ms in total length, with silence between syllables being 127 ± 8 ms (fig. 8). Syllables are composed of 6–18 pulses (with no normal distribution) and are 112 ms in mean length (41–249). Isolated syllables are of longer duration. Pulses are not uniformly distributed but tend to concentrate as the syllables progresses. Silence between pulses is 8.6 ms in mean length (0.3–62.2). Syllable duration is independent of number of pulses (Pearson's correlation coefficient = 0.173).

The syllables may present the most intense pulses at the beginning, although the pulses may be distributed in an apparently random way (fig. 9). Both types of syllable can be found within the same song.

The frequency spectrum shows a main peak at around 7600 Hz, with harmonics of higher frequency between 14000 and 19000 Hz (fig. 10). The lower quartile is around 6800 Hz, the medium quartile around 9000 Hz, and the higher quartile around 14500 Hz.

The sound is emitted under similar conditions to those of the 3S bio form.
In the presence of females 1S (Courtship song)

The song is 369 ± 12 ms in length, and is composed of 1-4 syllables separated by silences of 127 ± 8 ms in length (fig. 11). The syllables are 130 ms in mean length (47–214), and are composed of a mean of 14 pulses (6–22). Their structure is similar to syllables described above (of interaction/chorus song). Silence between pulses is 8.5 ms in mean length (1.2–41.9), and as seen before, the correlation between syllable length and number of pulses is low (Pearson's correlation coefficient = 0.374).

The frequency spectrum shows a main peak at around 7300 Hz, with harmonics of higher frequency between 14000 and 19000 Hz (fig. 12). The lower quartile is around 6700 Hz, the medium quartile around 9000 Hz, and the higher quartile around 14500 Hz.

The sound is produced under identical conditions to those seen for the 3S bio form.

Females 3S (Interaction song)

The song emitted by the 3S females is usually composed of a single syllable, although songs composed of 3 and 4 syllables have been observed on a few occasions (fig. 13).

The total length of the songs varies from 81 ± 41 ms (single syllable song) to 1-1.127 s (three and four syllables song, respectively). Silence between syllables is 200–550 ms in length. Syllables are composed of 1–6 pulses of variable intensity. Pulse duration is 61 ± 18 ms.

The frequency spectrum shows a main peak at around 7600 Hz, with harmonics of higher frequency between 14000 and 19000 Hz (fig. 14). The lower quartile is around 5900 Hz, the medium quartile around 8200 Hz, and the higher quartile around 12700 Hz.

Figures 13–14
Song of 3S females of Calliptamus barbarus. 13, Sound composed of three syllables. 14, Frequency spectrum.

Figures 15–16
Song of 1S females of Calliptamus barbarus. 15a, Sound composed of five syllables. 15b, sound composed of two syllables. 16a, Frequency spectrum with the main peak at around 8000 Hz. 16b, frequency spectrum with the main peak at around 16000 Hz.
Females 1S (Interaction song)

The song produced by the 1S females is composed of 1–5 syllables, with the most frequent songs being those that contain 1–2 syllables (figs. 15a and b). Total song length is very variable, between 99 and 1336 ms. Silence between syllables is 287 ± 43 ms, and syllables are composed of 1–12 pulses, 97 ± 11 ms in length. The intensity of the pulses is very variable and does not seem to follow an arranged pattern.

In 70% of the studied songs, the frequency spectrum shows a main peak at around 8000 Hz (fig. 14); the lower quartile is around 6100 Hz, the medium quartile around 8700 Hz, and the higher quartile around 12900 Hz. In 30% of the studied cases, the songs show a main peak around 16000 Hz; the lower quartile is around 7500 Hz, the medium quartile around 12300 Hz, and the higher quartile around 16000 Hz (figs. 16a and b).

It has been observed that the syllables that contain a main peak around 16000 Hz may be either the only syllable of the song or can be mixed with syllables of different spectral characteristics.

Since the songs showing these kinds of syllables have always been recorded in interaction circumstances with other females or with males, this special characteristic of a variable spectrum cannot be attributed to any particular behaviour.

Females of both bio forms produce a sound when interacting with other females or when rejecting a male. As with males, the sound is accompanied by a convulsive movement of the hind femora. 1S females produce sound much more frequently than 3S females.

Discussion

A comparison of the sounds produced by both sexes and both bio forms under different conditions leads to the following considerations.

The frequency of emission of the songs produced by males when accompanied by males of their own bio form is similar (t-Student = 0.115 p > 0.05), however, the syllabic length is different (U Mann-Whitney = 0, p < 0.05), with the syllables produced by 1S males being longer. The silence between pulses also differs, with the 3S males’ song being longer (U Mann-Whitney = 0, p < 0.05). The number of pulses per syllable is significantly greater in the 1S males’ song (U Mann-Whitney = 0.035, p < 0.05) (table 3).

Thus, the song produced by 3S males when they meet males of their own bio form is different to that

Table 3. Data summary concerning the physical characteristics of the songs emitted by the males of both bio forms, highlighting the significant differences between them.

<table>
<thead>
<tr>
<th></th>
<th>Males 3S</th>
<th>Males 1S</th>
</tr>
</thead>
<tbody>
<tr>
<td>Whole duration</td>
<td>357 ± 80 ms</td>
<td>686 ± 57 ms</td>
</tr>
<tr>
<td>Number of syllables</td>
<td>1-3</td>
<td>2-5</td>
</tr>
<tr>
<td>Silence between syllables</td>
<td>150.8 ms</td>
<td>127 ms</td>
</tr>
<tr>
<td>Syllable length**</td>
<td>71.8 ms</td>
<td>Males 1S Syllable length *</td>
</tr>
<tr>
<td>Number of pulses**</td>
<td>6</td>
<td>Number of pulses *</td>
</tr>
<tr>
<td>Silence between pulses**</td>
<td>14.9 ms</td>
<td>Silence between pulses *</td>
</tr>
<tr>
<td>Main frequency peak</td>
<td>7740 Hz</td>
<td>Main frequency peak</td>
</tr>
<tr>
<td></td>
<td>Females 3S</td>
<td>Females 1S</td>
</tr>
<tr>
<td>Whole duration</td>
<td>430 ± 60 ms</td>
<td>369 ± 12 ms</td>
</tr>
<tr>
<td>Number of syllables</td>
<td>1-3</td>
<td>1-4</td>
</tr>
<tr>
<td>Silence between syllables</td>
<td>181 ms</td>
<td>127 ms</td>
</tr>
<tr>
<td>Syllable length **</td>
<td>101.5</td>
<td>Males 1S Syllable length **</td>
</tr>
<tr>
<td>Number of pulses **</td>
<td>9</td>
<td>Number of pulses</td>
</tr>
<tr>
<td>Silence between pulses **</td>
<td>12.5 ms</td>
<td>Silence between pulses</td>
</tr>
<tr>
<td>Main frequency peak</td>
<td>7500 Hz</td>
<td>Main frequency peak</td>
</tr>
</tbody>
</table>

Significant differences in: Males / Males situations of both bio forms: *; Males/Males compared with Males/Females situations of the same bio form: **
produced by 1S males when meeting other 1S males, both in syllabic and pulses length and in the number of pulses per syllables.

Males of both bio forms show similar behaviour when meeting females. One of the behavioural units most frequently observed concerns the production of sound accompanied by convulsive movements of the hind femora, which, it is thought to constitute an identification signal for the male. In this situation, an up and down movement of the hind femora is performed by males of both bio forms, so that the inner face of the hind femora is visible. Since this behavioural unit offers a visual signal that differs according to the bio form, it can be interpreted as identification behaviour (Larrosa et al. 2004), independent from the actual sound emission.

In the different songs of 3S males emitted in the presence of males and females, significant differences in the number of pulses per syllable (U Mann-Whitney = 0.002, p < 0.05) and in the syllable length (U Mann-Whitney = 0, p < 0.05) were observed, with the syllables produced in the male-female interaction being significantly longer. For this reason, the pulse emission rate is also different. Since the sound is produced by mandibular friction, a lower pulse emission rate involves a slower movement of one mandible against the other. The silence between pulses is also significantly different, and is shorter when the males are accompanied by females (U Mann-Whitney = 0, p < 0.05) (table 3).

In the case of 1S males, the songs show a similar frequency spectrum (t-Student = 0.115, p > 0.05). The temporal song parameters (syllable length and number of pulses per syllable) are also similar under all conditions (U Mann-Whitney = 0.087, p > 0.05 and U Mann-Whitney = 0.180, p > 0.05, respectively). Thus, it can be concluded that the song emitted by 1S males is uniform in terms of number of pulses and syllabic length, and that there is no variation according to the sex of the specimen with which they interact. Nevertheless, the silence between pulses varies, and it is shorter when the males are accompanied by females (U Mann-Whitney = 0, p < 0.05) (table 3).

When the songs emitted by the females of both bio forms are compared (table 4), significant differences of up to 8000 Hz can be observed in the main frequency (U Mann-Whitney p < 0.05). It is known that the ability to distinguish between two songs with different main frequencies depends on the particular species, and Locusta migratoria L. 1758 has been identified as being capable to distinguish the smallest differences (2000 Hz) (Otte 1970; Stephen & Bennet-Clark 1982; von Helversen & von Helversen 1983). Other variables, such as the number of pulses and syllabic length, showed higher values in the 1S females (U Mann-Whitney p < 0.05), although, the number of pulses per time unit is not significantly different (U Mann-Whitney p > 0.05). Thus, the songs emitted by females of both bio forms can be distinguished by the syllabic length, and the number of pulses of the syllables.

Based on the above observations, significant differences exist in several parameters of the acoustic emission of the two bioforms of C. barbarus.

For most insects herbivores it is clear that the application of a broad biological species concept leads to the recognition of more species than the traditional

<table>
<thead>
<tr>
<th>Table 4. Data summary concerning the physical characteristics of the songs emitted by the females of both bio forms, highlighting the significant differences between them.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Males/Females 3M</strong></td>
</tr>
<tr>
<td>Whole duration</td>
</tr>
<tr>
<td>Number of syllables</td>
</tr>
<tr>
<td>Silence between syllables</td>
</tr>
<tr>
<td>Syllable length</td>
</tr>
<tr>
<td>Number of pulses</td>
</tr>
<tr>
<td>Main frequency peak</td>
</tr>
</tbody>
</table>

Significant difference: *
purely morphological approach. In particular, the widespread occurrence of groups of sibling species can only be demonstrated by a biological approach (Claridge et al. 1997).

The most useful definition for the establishment of the concept of biological species has been proposed by Mayr (1942). The biological species have been developed and redefined over the last half century, particularly by Bock (1986, 2004), Cain (1954), Dobzhansky (1970), Mayr (1963, 1982), Mayr & Ashlock (1991), etc, always using the concept of isolation.

A major criticism of the biological species has been developed by Paterson (1985, 1993). In these studies, he developed a new concept, which he termed the recognition concept.

Differences between the isolation and recognition concepts has generated much controversy and discussion. (Lambert & Spencer 1995; Mayr 1988). Nevertheless, Claridge (1988, 1995) thinks that both are similar concepts that will usually allow the recognition of the same entities as species.

Mayr (2000), as a major critical of the concept of biological species, considers that the species are centered around reproductive communities wherein there is both an ecological and genetic unit. Individuals within the species seek and recognize one another for mating, and thereby maintain an intercommunicating genetic pool. The consequence of this is a selection reward for acquiring mechanisms, termed isolation mechanisms, which may allow breeding with conspecific individual but prevent copulation with others. Accordingly, speciation is the process of achieving reproductive isolation (Mayr 1970), which becomes an isolating mechanism.

Since sound constitutes an intraspecific recognition system during the reproductive process (Blondheim 1990; García et al. 1996), following the Mayr (2000) biological species concept, we can consider that the differences related to morphology (Clemente et al. 1987), behaviour (Larrosa et al. 2004, 2007) and sound reported in this study, may represent the mechanisms of isolation between the two bioforms of *C. barbarus*. Therefore, both bioforms appear to be following a speciation process through reproductive isolation.

Further studies, genetic, comparative behaviour (in progress), are needed in order to establish the specific status of both bioforms.

References


