



FROGLOG

Newsletter of the Declining Amphibian
Populations Task Force

October 1998, Number 29.



DAPTF Seed Grants 1998

We have just completed this year's Seed Grant round. We received a total of 53 proposals, of which we have been able to fund 15. For the first time, we have been able to give some grants (three) to support the invaluable work of our Regional Working Groups (The Ivory Coast, Uganda and South Asia). The total value of the 15 grants is \$31,980. On behalf of the DAPTF, I would like to thank those who helped to referee the proposals: Pim Arntzen, Christine Bishop, Cindy Carey, Ron Heyer and John Wilkinson. Details of these and previous Seed Grants are available from the DAPTF Office.

Tim Halliday, *International Director.*



The Decline of Amphibian Diversity in Exploited Forests

By Nguyen Quang Truong

During April and May 1998, scientists of IEBR, Vietnam and AMNH, USA conducted research into the biodiversity of Central Vietnam.

A group of herpetologists studied and defined the biodiversity of amphibians in the Northern Truong Son range. Two methods were used for collecting specimens. (1) The herpetofauna was sampled in each sector; amphibians were actively searched for by day and (mainly) by night by examining vegetation and other cover that may harbour different amphibian species. Individuals were collected as they were encountered. (2) Traps were used to collect toads at different elevations. Observations were also used to define the frequency of occurrence of species in the research areas. We chose two kinds of forest in the Huong Son area (Ha Tinh province); tropical evergreen mountain forest (in the Rao An part)

and exploited forest (in the Nga Doi part).

We collected most specimens in the first type of forest. This habitat is very good for supporting amphibians and providing their breeding sites. There are many streams with a high water level and dense tree cover. Twenty-six species were found there (Pelobatidae: 4 species, Bufonidae: 2 species, Ranidae: 10 species, Rhacophoridae: 6 species and Microhylidae: 4 species). Among them, there are 5 species recorded in Red Data Book of Vietnam (1992) (Threatened: *Megophrys longipes*, *Rana andersoni*, *Rana spinosa*, *Rhacophorus nigropalmatus*, Rare: *Bufo galeatus*).

In the second kind of forest we found only 13 species (Bufonidae: 1 species, Ranidae: 8 species, Rhacophoridae: 2 species and Microhylidae: 2 species). Among these, 3 species are recorded in the Red Data Book of Vietnam (1992) (Threatened: *Rana andersoni*, *Rana spinosa*, *Rhacophorus nigropalmatus*).

The density of amphibians in the two areas differed. In Rao An we collected more than 200 specimens but in Nga Doi only 35. The frequency of occurrence of some species (e.g. *Rana andersoni*, *Rana spinosa*, *Rhacophorus leucomystax*) in Rao An is very high (they can be found everywhere) but in Nga Doi it is very low.

Based on these results, we are able to compare the diversity of amphibians between the two kinds of forest. These areas are separated from each other by just a road but the status of the forest and its frogs is very different. The forest in Nga Doi is exploited and consists mainly of middle-sized and small trees. The degree of forest cover is reduced, the river system is smaller and the water level is lower. Amphibian habitat has been restricted because some streams were waterless. Additionally, mechanical forestry and wood-transport methods create a continuous noise that may be a negative influence for breeding

amphibians.

I believe the herpetofauna will begin to decline if we do not protect amphibian living and breeding habitat. We may need to exploit forest at a necessary minimum level, but we must stop exploiting these forests as soon as possible in order to conserve their biodiversity.

Contact: Nguyen Quang Truong, Institute of Ecology and Biological Resources, Nghia Do, Cau Giay, Hanoi, VIETNAM.

Tel: 84 4 7562810, Fax: 84 4 8361196

E-mail: sung@iebr.ac.vn (marked "for Nguyen Quang Truong")



New Records of "Declining" Frogs in Queensland, Australia

By Jean-Marc Hero, Harry Hines,
Edward Meyer, Clare Morrison,
Craig Streatfeild and Lewis Roberts

Since the late 1970s, at least 14 frog species have declined or disappeared from rainforest areas of Queensland, Australia (Richards *et al* 1993, Ingram and McDonald 1993, Hero 1996). Declines/disappearances are defined as a substantial decrease in number of populations, such as populations no longer found at sites where they were recorded historically or, in some cases, where all known populations have disappeared. Declines have primarily been reported for stream-dwelling species from three relatively undisturbed upland areas: 1) the subtropical rainforest in the mountain ranges surrounding Brisbane, 2) the Eungella tropical rainforest west of Mackay and 3) the Wet Tropics tropical rainforest between Townsville and Cooktown.

Declines have primarily been documented in populations at altitudes over 300m above sea level (Richards *et al* 1993, Laurance *et al* 1996, M. Hero *pers. obs.*). The species that have been most affected generally have the following characteristics;

eggs, larvae and/or adult stages within the stream environment, small clutch sizes and restricted geographic ranges (Hero 1996, Williams & Hero 1998, Hero *unpubl. data*). The cause(s) of the declines in Queensland's upland rainforest is still unclear (Richards *et al* 1993, Laurance *et al* 1996, Hero 1996). Recent work by Berger *et al* (1998), however, indicates the possible involvement of a fungal pathogen in the declines.

Whilst the monitoring of some declining species is ongoing (Queensland National Parks and Wildlife Service (QNPWS), Griffith University Gold Coast, the University of Queensland and James Cook University), there is a severe lack of funding for declining frog research in Queensland. Consequently, miscellaneous searches must be used to obtain information on the current status of endangered species. Here we report on surveys conducted in southeastern Queensland in November 1997, mid-eastern Queensland since 1993, the Wet Tropics Rainforest in February 1998, and a miscellaneous record by L. Roberts from January 1997. Thorough analyses of historical and recent records, and results of long-term monitoring projects are currently in preparation for publication. Recovery plans that assess the status of the declining amphibians in Queensland are currently in preparation by the QNPWS.

South-East Queensland

Taudactylus diurnus and *Rheobatrachus silus* are now thought to be extinct. In the late 1970s to mid 1980s, several species (*Mixophyes iteratus*, *M. fleayi*, *Litoria pearsoniana*) appear to have suffered similar declines (Ingram & McDonald 1993). The extent and severity of declines is difficult to gauge since survey data are not available to compare current with historical population levels.

In November 1997, two areas of southeast Queensland, the Blackall/Conondale Ranges and the Border Ranges (Lamington National Park), were surveyed for declining species. Seven streams were surveyed in the former locality and 3 in the latter. Twenty-three species of frogs including 3 "declining" species were located. Details of the results of these searches follow. No sick or dying frogs were encountered during these surveys.

Southern Day Frog (*Taudactylus diurnus*) and Southern Gastric-brooding Frog (*Rheobatrachus silus*) Despite continued searches of

historical sites, neither species has been encountered since 1979 and 1981 respectively (Czechura & Ingram 1990, Stephen Richards *pers. comm.*). Both species are now presumed extinct.

Giant Barred Frog (*Mixophyes iteratus*) *M. iteratus* was encountered on 5 out of 16 transects in the Blackall and Conondale Ranges. Surveys uncovered one new population and one new sub-population. Remaining reports were from Gheerulla Creek, a site where this species has been recorded historically. Searches of historical sites in the Conondale Ranges during 1993 and 1995 failed to locate this species (Ingram & McDonald, 1993; M. Cunningham, *pers. comm.*) More recent surveys have uncovered a population on Six Mile Creek. The reproductive phenology and activity of this species is poorly known. Assessment of the species' status in Queensland requires continued monitoring of historical sites and the new sites reported here, as well as searches of new sites.

Fleay's Barred Frog (*Mixophyes fleayi*) *M. fleayi* was encountered on 3 out of 16 transects in the Blackall and Conondale Ranges, representing 3 new sites within a watershed not previously known to have this species. In Lamington National Park, *M. fleayi* was encountered on 3 out of 7 transects. Tadpoles and gravid females were found, indicating spring and summer breeding activity. Small numbers of *M. fleayi* were also found in a new population (following a report by Brent Dadds) in the Cougal National Park (160m altitude), Springbrook Range, at a considerable distance from previously known sites. These records (with the exception of the new Cougal record) fall within the known altitudinal range for this species and are not consistent with declines of this species in the Wet Tropics which have predominantly occurred at altitudes of above 300m (Richards *et al* 1993, Laurance *et al* 1996). The species requires monitoring as for *M. iteratus*.

Great Barred Frog (*Mixophyes fasciolatus*) This species was encountered on 12 out of 16 transects in the Conondale ranges. Spring and summer breeding activity was again evident. Unlike its congeners, *M. iteratus* and *M. fleayi*, this species is not known to have declined.

Cascade Treefrog (*Litoria pearsoniana*) This species was found on 12 out of 16 transects in the Conondale Ranges and on all 7 transects surveyed in Lamington

National Park. Both tadpoles and gravid females were located indicating spring and summer breeding activity. This is consistent with reports of abundant populations found throughout southeastern Queensland between 1993 and 1997 (McGuigan *et al* 1998, M. Cunningham *pers. obs.*). Following reports of declines in 1978 and 1984 (Ingram & McDonald 1993) numbers of *L. pearsoniana* appear to have recovered and stabilized (McGuigan *et al* 1998).

Mid-East Queensland

Following an extensive search in 1993 (Hero 1996), continuous surveys of streams at high and low altitudes have been conducted throughout each year from 1994-1998 (Retallick, Hero & Alford *unpubl. reports*).

Eungella Gastric Brooding Frog (*Rheobatrachus vitellinus*) Despite continued searches at several historical sites, *R. vitellinus* has not been encountered since its disappearance and it is now presumed extinct. Surveys to date have focussed on historical sites and future surveys should include searches in adjacent watersheds that may contain suitable habitat for this species.

Eungella Dayfrog (*Taudactylus eungellensis*) This species disappeared in 1987 (McDonald 1990) and was rediscovered in 1992 (Couper 1993). Populations of *T. eungellensis* have been monitored consistently throughout 1994-1998 along sections of streams at medium altitudes (280-550m). During this time population numbers have remained relatively stable with distinct peaks in abundance in late summer and autumn (March-May). Sick and dying *T. eungellensis* were occasionally encountered in 1994 and 1995 and were sent to the Australian Health Laboratory for pathogen analysis (Berger *et al* 1998). Continued monitoring is essential to ensure that the known populations are stable.

Eungella Tinkerfrog (*Taudactylus liemi*) Due to the cryptic nature of this species, abundance estimates are dependent on calling activity. This species has been heard calling following rains throughout the year at many sites at all altitudes and its population is considered stable. Unlike its congener, *T. eungellensis*, this species is not known to have declined.

North-East Queensland

Declines in frog populations in rainforest areas in the Wet Tropics biogeographic area were first noted in the late 1980s (Richards *et al* 1993). In total, 7 species have declined or disappeared from this area (Richards

et al 1993, Ingram & McDonald 1993, Trenerry *et al* 1994, Hero 1996, Williams & Hero 1998). The mountain mist frog (*Litoria nyakalensis*) and the armoured mist frog (*Litoria lorica*) have been missing since 1990 and 1991 respectively, and have yet to reappear. The waterfall frog (*L. nannotis*), the common mist frog (*L. rheocola*) and the Australian lace-lid (*Nyctimystes dayi*), have disappeared from many upland areas, yet they persist below 300m altitude (Richards *et al* 1993, Hero 1996, Laurance *et al* 1996, Williams & Hero 1998). The demarcation between lowland and upland areas is not clearly defined as several populations have persisted at altitudes over 600m between 1990 and 1997 (Richards *et al* 1993, Trenerry *et al* 1994, Hero 1996, Hero *unpubl. data*).

Northern Tinkerfrog (*Taudactylus rheophilus*) A single juvenile of this species was found in February 1998 on the southeastern slope of Bellenden Ker, at approximately 1,400m altitude, where Marshall (1998) heard this species calling in 1996. Several *Cophixalus neglectus* and *C. ornatus* (Microhylidae) were also encountered nearby. No frogs were seen or heard on the northwestern slope. A second population of *T. rheophilus* reported by Marshall (1998) persists on Mt. Lewis (Cape York Herpetological Society Newsletter, 1997).

Sharp-Snouted Dayfrog (*Taudactylus acutirostris*) L. Roberts encountered a single gravid female of this species in January 1997 on a small creek near Mt. Hartley at about 550m altitude. This is the second record of *T. acutirostris* since 1994 (Marshall 1998). No individuals were seen or heard during searches for this species in February 1998.

Waterfall Frog (*Litoria nannotis*) We found this species in February 1998 on a transect along a fast-flowing boulder stream at 780m altitude on the south-eastern slope of Mt. Father Clancy. A moribund *L. genimaculata* was also found and was sent to the Australian Animal Health Laboratory for pathogen analysis. Despite widespread declines in this species at higher altitudes (Richards *et al* 1993), *L. nannotis* has been found at locations over 600m above sea level since 1994 (Hero 1986, Hero *unpubl. data*).

Summary

A major obstacle for evaluating declines in Queensland is the lack of historical systematic, quantified surveys. The majority of records are based on historical museum records

and short-term follow-up surveys, the results of which may or may not have reflected the population status of each species at that time (there are some exceptions e.g. Czechura & Ingram 1990, McDonald 1990, Ingram & McDonald 1993, Richards *et al* 1993).

This report also highlights some problems associated with assessing amphibian populations and the important distinction between "population size" and "number of populations" (*viz* Green 1997). The stochastic nature of amphibian populations makes the former (quantifying the number of individuals within populations) difficult to interpret without long-term data. The latter (surveying a number of populations on a broad scale, rather than individuals within populations) is more appropriate for rapid assessment of species population status.

Herein, we have provided information on new populations (found prior to February 1998) of several endangered species that have been "missing" for several years (*Taudactylus spp.*). These records give us some hope that other "missing" species may not be extinct. The significance of these records is important for understanding population declines, and may help us evaluate the hypotheses currently proposed to explain these declines (Richards *et al* 1993, Laurance *et al* 1996, Mahoney 1996, Hero & Gillespie 1997, Richards & Alford 1997, Berger *et al* 1998).

These new populations may represent (a) naïve remnant populations that have not been exposed to the factor/s causing the declines or (b) remnant populations that have survived exposure to these factor/s and which are in the process of population recovery. It should be noted that until the cause/s of the declines is/are known, the status of each species may not be linked to a single cause. Regardless of the outcome, the small remnant populations are susceptible to extinction due to the demographic instability of small populations (small population paradigm *viz* Caughley & Gunn 1996) and continued surveys and monitoring are urgently required to ensure that they are managed appropriately.

Comprehensive surveys and monitoring throughout Queensland are essential to determine the status of the remnant populations encountered in the surveys presented here. Furthermore, research is urgently required to:

1) Evaluate the hypotheses proposed to explain the declines.

2) Determine the reasons for the patchy distribution of remnant populations at high altitudes.

3) Examine the influence of altitude on the ecological characteristics of amphibians.

4) Determine and evaluate the significance of the ecological characteristics shared by the declining species which make them more susceptible to extinction than species that appear to be unaffected.

5) Develop husbandry techniques to maintain captive populations of declining frogs that are in danger of extinction in the wild (e.g. members of the genus *Taudactylus*).

Acknowledgements This research was partially funded by Linda Mealy, the Wet Tropics Management Authority, the Queensland Department of the Environment, Griffith University Gold Coast, James Cook University of North Queensland and the society for Restoring Australian Native Amphibians (RANA). We are especially grateful to Michael Cunningham, Sheree Fickling, Steve Williams, Emily Bolitho, Bill Smith, David James, Step Lawler, Don Driscoll, Conrad Hoskin, Graeme Gillespie and all the participants of field trips and "Missing Frog Searches" between 1993 and 1997.

Literature Cited

- Berger, L., Speare, R., Daszak, P., Green, D.E., Cunningham, A.A., Goggin, C.L., Slocumbe, R., Ragan, M.A., Hyatt, A.D., McDonald, K.R., Hines, H.B., Lips, K.R., Marantelli, G. & Parkes, H. (1998) Chitridiomycosis causes amphibian mortality associated with population declines in the rainforests of Australia and Central America. *Proc. Nat. Acad. Sci. USA* **95**: 9031-9036.
- Caughley, G. & Gunn, A. (1996) *Conservation Biology in Theory and Practice*. Blackwell Science, Cambridge, Massachusetts.
- Couper, J. (1993) Hope for our missing frogs. *Wildl. Aust.* **29**: 11-12.
- Czechura, G.V. & Ingram, G.J. (1990) *Taudactylus diurnus* and the case of the disappearing frogs. *Memoirs of the Queensland Museum* **29(2)**: 361-365.
- Green, D.M. (1997) *Amphibians in Decline: Canadian Studies of a Global Problem*. Herpetological Conservation, SSAR & Canadian Association of Herpetologists.
- Hero, J.-M. (1996) Where are Queensland's missing frogs? *Wildl. Aust.* **33**: 8-13.
- Hero, J.-M. & Gillespie, G.R. (1997) Epidemic disease and amphibian declines in Australia. *Cons. Biol.* **11**: 1023-1025.
- Ingram, G.J. & McDonald, K.R. (1993) An update on the decline of Queensland's frogs. *Herpetology in Australia*, 297-303.
- Laurance, W.F., McDonald, K.R. & Speare, R. (1996) Epidemic disease and the catastrophic decline of Australian rainforest frogs. *Cons. Biol.* **10**: 406-413.
- Mahoney, M. (1996) The decline of the green and golden bell frog *Litoria aurea* viewed in the context of declines and disappearances of other Australian frogs. *Aust. Zool.* **30**: 237-247.

Marshall, C.J. (1998) The reappearance of *Taudactylus* (Anura: Microhylidae) in north Queensland streams. *Pac. Cons. Biol.* In press.

McDonald, K.R. (1990) *Rheobatrachus* Liem and *Taudactylus* Straughn and Lee (Anura: Leptodactylidae) in Eungella National Park: Queensland distribution and decline. *Trans. R. Soc. S.A.* **114**: 187-194.

McGuigan, K., McDonald, K., Parish, K. and Moritz, C. (1998) Mitochondrial DNA diversity and historical biogeography of a wet forest-restricted frog (*Litoria pearsoniana*) from mid-east Australia. *Mol. Ecol.* **7**: 175-186.

Retallick, R.W.R. (1998) *Population Monitoring of Stream-Dwelling Frogs at Eungella National Park*. Unpublished report to Environment Australia Biodiversity Group and the Queensland National Parks and Wildlife Service. 46pp.

Retallick, R.W.R., Hero, J.-M., & Alford, R. (1997) *Ecology of the Stream-Dwelling Amphibians of Eungella National Park*. Final report to Australian Nature Conservation Agency and the Queensland National Parks and Wildlife Service. Internal report: 62pp.

Richards, S.J. & Alford, R.A. (1997) Epidemic disease and amphibian declines in

Australia. *Cons. Biol.* **11**: 1026-1029.

Richards, S.J., McDonald, K.R. & Alford, R.A. (1993) Declines in populations in Australia's endemic tropical rainforest frogs. *Pac. Cons. Biol.* **1**: 66-77.

Trener, M.P., Laurance, W.F. & McDonald, K.R. (1994) Further evidence for the precipitous decline of endemic rainforest frogs in tropical Australia. *Pac. Cons. Biol.* **2**: 150-153.

Williams, S.E. & Hero, J.-M. (1998) Rainforest frogs of the Australian wet tropics: guild classification and the ecological similarity of declining species. *Proc. Roy. Soc. Lond. B.* **265**: 597-602.

Contact the authors through: J.-M. Hero, School of Applied Science, Griffith University Gold Coast, PMB 50 Gold Coast MC, Queensland, 4127 AUSTRALIA.

m.hero@eas.gu.edu.au

Report of the DAPTF
Atmospheric and Global
Change Working Group



By Cindy Carey,
Working Group Chair

Ron Heyer (DAPTF Chair) and I are co-principal investigators on a grant awarded by NASA (the US Space Agency) in September 1997. The purpose of this grant is to examine whether or not a direct link exists between global climate changes and amphibian declines. We asked the following individuals, who know exactly when and where die-offs have occurred, to join us in choosing the variables to be examined (Stan Rand:

Brazil; Karen Lips: Central America; Stan Orchard: Canada, Alan Pounds: Central America; and Ross Alford: Australia).

At our first meeting at the NASA Goddard Space Flight Center in December 1997, it became clear that a most important need existed for a global mapping of all information currently available concerning where extinctions and declines have occurred, where species have populations at relatively "normal" levels, and where no information exists. Such a map would be constructed in a GIS format, so that various variables, such as altitude, species, life stages affected, etc. could be mapped on top of the location. John Wilkinson was added to our team for the purpose of collecting the data; he is currently soliciting information from various investigators, which will be overlaid with NASA's climate data. One likely outcome of this project is publication of the GIS map and analysis of any patterns and trends that emerge.

It also became clear at our first meeting that choice of the variables to analyze was extremely difficult. Satellite data for the die-offs in the temperate zones in the 1970's are spotty and less accurate than more recent data. Use of any satellite data set also requires information about who has the data set, how data are encrypted for storage, how accurate the data are, how large the "picture frame" is, etc. Since none of us has such expertise, it was decided that the project should proceed in two stages: first, a meeting of our team with climatologists should take place so that they could recommend which data sets would likely yield the most useful, accurate information for sites at which die-offs have occurred, and then individuals who use those data sets would be enlisted to run their data for us.

A meeting took place in Boulder, Colorado, between members of our team and individuals from the National Center for Atmospheric Research, National Oceanic and Atmospheric Administration, Climate Diagnostic Center of the University of Colorado, and National Snow and Ice Data Center. We asked them to detail what sorts of variables within their areas of expertise had changed in the temperate zones in the 1970s and in the tropics in the late 1980s-early 1990's. They reported on a number of factors relating to changes in the patterns of El Niño - Southern Oscillation events that have resulted in changes in temperature and precipitation in many areas in which

die-offs have occurred. Since many die-offs have occurred at "high" altitude (in the tropics from 400-600 m upward), we asked what sorts of climatic factors have been changing in the mountains of the world. The reports indicated that thermal minima, but not maxima, have been rising in temperate mountain ranges, with the result that diurnal temperature swings have decreased. The 0°C isotherm has been rising in the mountains of the tropics, with the result that the freezing line has risen almost 300 m in equatorial mountains. Other reports described other global factors that would be worth investigating.

We concluded that we should focus our efforts on locations at which die-offs have happened recently (Central America, Australia and eastern Puerto Rico) for which the most accurate and most plentiful data exist. We are currently contracting individuals to run data sets for us on temperature, rainfall and other hydrological variables, UV-B, atmospheric contaminants, and wind patterns for these locations.

Contact: Cynthia Carey, Dept. of EPO Biology, University of Colorado, N122 Ramaley, Campus Box 334, Boulder, CO 80309-0334, USA.

Cynthia.Carey@Colorado.EDU



DONATIONS

We gratefully acknowledge receipt of the following donations from 1 July through 15 September 1998.

Organizations: Earth Images (Nancy Cannon); Upstate Herpetological Association. **Individuals:** Thane Caro; Benjamin C. Hammett; Susan Jewett; Beverly McGrane; Moira Hope; Sarah M. Talpey; John Thomison.



Publications of
Interest

Dodd, C.K. & Cade, B.S. (1998) Movement patterns and the conservation of amphibians breeding in small, temporary wetlands. *Conservation Biol.* **12**: 331-339.

Jancovich, J.K., Davidson, E.W., Morado, J. F., Jacobs, B. L. & Collins, J. P. (1997) Isolation of a lethal virus from the endangered tiger salamander *Ambystoma tigrinum stebbinsi*. *Diseases of Aquatic Organisms* **31**: 161-167.

Lannoo, M.J. (Ed.) (1998) *Status and Conservation of Midwest Amphibians*. University of Iowa Press, Iowa City.

507pp. ISBN: 0-87745-632-1. To order this book call (USA) 773-568-1550. Softcover copies are \$30 ea. and hardcover copies \$50 ea. *Essential reading for anyone involved in researching or conserving the amphibia of the Midwestern United States.*

McAlpine, D.F., Burgess, N.M. & Busby, D. G. (1998) Densities of mink frogs, *Rana septentrionalis*, in New Brunswick forest ponds sprayed with the insecticide fenitrothion. *Bull. Environ. Contam. Toxicol.* **60**: 30-36.

Mizgireuv, I.V., Flax, N.L., Borkin, L.J. & Khudoley, V.V. (1984) Dysplastic lesions and abnormalities in amphibians associated with environmental conditions. *Neoplasma* **31**: 175-181.

Ryan, T.J. (1998) Larval life history and abundance of a rare salamander, *Eurycea junaluska*. *J. Herpetol.* **32**: 10-17.



FROGLOG is the newsletter of the Declining Amphibian Populations Task Force. Partial funding for FROGLOG is provided by donation from: Frog's Leap Winery, P.O. Box 189, Rutherford, CA 94573, USA.

Edited by: John W. Wilkinson, Department of Biology, The Open University, Walton Hall, Milton Keynes, MK7 6AA, United Kingdom.

Phone: +44 (0) 1908 - 652274.

Fax: +44 (0) 1908 - 654167

E-mail: dapf@open.ac.uk