FLORA & FAUNA GUARANTEE

FLORA AND FAUNA GUARANTEE - SCIENTIFIC ADVISORY COMMITTEE

FINAL RECOMMENDATION ON A NOMINATION FOR LISTING

Infection of amphibians with Chytrid fungus, resulting in Chytridiomycosis

(Potentially Threatening Process)

Date of receipt of the nomination: 1 September 2003 **File No.:** FF/54/0311
Date of preliminary recommendation: 2 September 2003
Date of final recommendation: 11 November 2003

Validity: The nomination is for a valid item

Prescribed Information: The prescribed information was provided.

Name of the Nominator is adequately provided.

Name and Description of the process:

In the opinion of the SAC the process is adequately defined and described.

The nomination is defined as 'Infection of Amphibians with Chytrid Fungus, resulting in Chytridiomycosis'

Chytridiomycosis is a fatal disease of amphibians caused by the chytrid fungus *Batrachochytrium dendrobatidis* (Longcore *et al.* 1999). The fungus is virulent only to adult amphibians, however it has been found, and therefore may be carried, on the keratinised mouthparts of tadpoles (Berger *et al.* 1999). The fungus does not appear to rely on susceptible (stressed) hosts for survival and persists in populations where the density of adults has been reduced (Daszak *et al.* 1999). Further, other poikilotherms with keratinised surfaces could harbour and help to spread the disease, although this has not yet been observed.

Two explanations have been proposed as to how the organism kills frogs (Berger *et al.* 1998, Pessier *et al.* 1999). The sporangia may release fatal toxins that are absorbed by the semi-permeable skin or alternatively, the disease damages the epidermis which affects water and/or electrolyte balance.

Chytridiomycosis is a global epidemic. It is now known to occur in Australia, New Zealand, Europe, North America, Central America, South America and Africa (Speare and Berger 2000a). In Australia, chytridiomycosis has been observed in frog populations from four geographic areas: a large eastern zone extending from Big Tableland (near Cooktown) south to Melbourne; an Adelaide zone; a zone in south-west Western Australia to just north of Perth; and a zone in the central Kimberleys.

The first known occurrence of the disease in Australia (determined via retrospective examination of museum specimens) was in south-east Queensland from a specimen collected in December 1978 (Speare and Berger 2000b). The subsequent spread of the disease may in part be attributed to both the international and domestic trade in amphibians as pets. Similarly, frogs are often accidentally transported with agricultural produce, as demonstrated by infected frogs that were rescued from produce (eg. bananas) in Melbourne (Marantelli and Hobbs 2000). Collection and handling of frogs and inadvertent transport of infected material between frog habitats may also promote the disease's spread.

Chytridiomycosis is potentially fatal to all native species of amphibian. As such, all frog species that are listed under the schedules of the Act may be affected by the disease.

High altitude (>400m) populations are more severely affected by chytridiomycosis. This may be explained by the influence of temperature on *Batrachochytrium dendrobatidis*. Such population declines have been reported from the NSW uplands (Gillespie and Hines 1999, Hines *et al.* 1999), the Victorian alps (Gillespie and Marantelli 2000) and the Queensland wet tropics (Laurance *et al.* 1996, McDonald and Alford 1999).

Stream-associated frog species are more likely to be infected because the pathogen is waterborne. The following are stream-breeding species of the Victorian coast and ranges and may be threatened by chytridiomycosis (Gillespie and Hines 1999): Booroolong Frog *Litoria booroolongensis* Spotted Tree Frog *Litoria spenceri* Southern Barred Frog *Mixophyes balbus* Giant Burrowing Frog *Heleioporus australiacus*

Species of stream-breeding frog which are not threatened but may become threatened include:- Eastern Banjo Frog *Limnodynastes dumerilii*, Lesueur's Frog *Litoria lesueuri* and Leaf-green Tree Frog *Litoria phyllochroa*.

The appearance of chytridiomycosis in a frog population may make it less able to withstand other threatening processes. The death of adult frogs from the disease - in concert with such threats as predation of tadpoles by exotic fish (e.g. Plague Minnow, *Gambusia holbrooki*), loss and degradation of habitat, and isolation of sub-populations would increase a local population's vulnerability to extinction.

The range of flora or fauna affected or potentially affected was adequately stated in the nomination.

The significance of the threat which the potentially threatening process poses or has the potential to pose was adequately stated in the nomination.

Eligibility for listing as a potentially threatening process under the Flora and Fauna Guarantee

The nominated item satisfies at least one criterion of the set of criteria prepared and maintained under Section 11 of the **Flora and Fauna Guarantee Act 1988**, and stated in Schedule 1 of the Flora and Fauna Guarantee Regulations 2001.

Evidence that criteria are satisfied:

Sub-criterion 5.1.1 *the potentially threatening process poses or has the potential to pose a significant threat to the survival of two or more taxa.*

Evidence:

The infection of Amphibians with chytrid fungus, resulting in chytridiomycosis, poses a significant threat to the survival of at least three Victorian frog species – *Litoria spenceri*, *Philoria frosti* and *Mixophyes balbus*, species already listed under the **Flora and Fauna Guarantee Act 1988**. In addition, all Victorian frog species appear to possess the traits indicative of susceptibility to population decline from the fungus, including inhabitation of areas where the fungus is likely to spread.

Despite evidence suggesting that not all susceptible species decline from exposure to the fungus (Berger *et al.* 1999), infection with chytridiomycosis has been shown experimentally to cause decline and has been implicated in the decline and extinction of species within Australia and overseas (Berger *et al.* 1999; Daszak *et al.* 1999; Bosch *et al.* 2001). All current evidence suggests that Victorian frog species (see Table 1) are likely to be susceptible to infection with the fungus and are likely to undergo population decline, potentially to the point of compromising species persistence (ie. extinction). The threat of extinction is particularly high for species already classified as 'Vulnerable' or 'Endangered', such as *L. spenceri*, *M. balbus*, *P. frosti* and *Heleioporus australiacus*, as these species have small population sizes.

Sub-criterion 5.2.1 *the potentially threatening process poses or has the potential to pose a significant threat to the evolutionary development of two or more taxa*

Evidence:

The infection of amphibians with the chytrid fungus poses a significant threat to the evolutionary development of frog species, such as *L. spenceri*, *M. balbus*, *P. frosti* and *H. australicus* (and potentially all species listed in Table 1). The infection of these frog species with the chytrid fungus may instigate catastrophic population declines, threatening future persistence of these species and therefore their evolutionary development. The fungus does not appear capable of instigating mass mortality within tadpoles, however current evidence suggests indiscriminate impacts upon all post-metamorphic individuals.

Table 1: List of frog species native to Victoria, indicating conservation status –listing under the Flora and Fauna Guarantee Act 1988 (FFG) and its recognised status within Victoria. Species which have been identified with chytridiomycosis (including whether the infected individual was discovered in Victoria) are indicated.

FROG SPECIES	FFG	Victorian conservation status	History of Chytridiomycosis
Litoria aurea	Not Listed	Near threatened	Yes
L. booroolongensis	Listed	Critically Endangered	?
L. citropa	Not Listed	Presumed secure	Yes
L. ewingi	"	"	Yes
L. lesueuri	"	"	Yes (Vict.)
L. littlejohni	Listed	Data deficient	No
L. nudidigitalis	Not Listed	Presumed secure	"
L. paraewingi	"	"	"
L. peroni	"	"	"
L. phyllochroa	"	"	"
L. raniformis	Listed	Endangered	Yes
L. spenceri	"	Critically Endangered	Yes (Vict.)
L. verreauxii alpina	"	Critically Endangered	No
Crinia parinsignifera	Not Listed	"	"
C. signifera	"	"	"
C. sloanei	"	"	"
Geocrinia laevis	"	"	"
Geocrinia victoriana	"	"	"
Heleioporus australiacus	Listed	Vulnerable	Yes
Limnodynastes dumerili	Not Listed	Presumed secure	Yes
L. fletcheri	"	Data deficient	No

L. interioris	Listed	Critically endangered	"
L. peroni	Not Listed	Presumed secure	"
L. tasmaniensis	"	"	Yes
Mixophyes balbus	Listed	Critically endangered	Yes
Neobatrachus pictus	Not Listed	Presumed secure	No
N. sudelli	""	"	"
Paracrinia haswelli	"	"	"
Philoria frosti	Listed	Critically endangered	"
Pseudophryne bibroni	Not Listed	Endangered	"
P. dendyi	"	Data deficient	"
P. semimarmorata	"	Vulnerable	"
Uperoleia laevigata	"	Presumed secure	"
U. martini	"	Data deficient	"
U. rugosa	Listed	"	"
U. tyleri	Not Listed	Presumed secure	"

Additional Information

- There is a large local and international literature on the threat of chytridiomycosis and its impact on amphibians (see references).

Advertisement for public comment

In accordance with the requirements of Section 14 of the **Flora and Fauna Guarantee Act 1988**, the preliminary recommendation was advertised for a period of at least 30 days.

The preliminary recommendation was advertised in:
'The Age' - on 1 October 2003
'The Weekly Times' - on 1 October 2003
The *Government Gazette* - on 2 October 2003
Submissions closed on 6 November 2003.

Further evidence provided:

Three submissions were received but no evidence was provided to warrant a review of the Scientific Advisory Committee's preliminary recommendation that the potentially threatening process is eligible for listing.

Documentation

The published information provided to the SAC has been assessed. Based on the available evidence, the SAC believes that the data presented are not the subject of scientific dispute and the inferences drawn are reasonable and well supported.

Final Recommendation of the Scientific Advisory Committee

The Scientific Advisory Committee concludes that on the evidence available the nominated item is eligible for listing in accordance with Section 11 of the Act because sub-criteria 5.1.1 and 5.2.1 have been satisfied. The SAC also concludes that no evidence exists to suggest that primary criteria 5.1 and 5.2 cannot be satisfied as a consequence of sub-criteria 5.1.1 and 5.1.2 being satisfied.

The Scientific Advisory Committee recommends that the nominated item be supported for listing on Schedule 3 of the **Flora and Fauna Guarantee Act 1988**.

Selected references:

Aplin, K. & Kirkpatrick, P. (2000) Chytridiomycosis in southwest Australia: historical sampling documents the date of introduction, rates of spread and seasonal epidemiology, and sheds new light on chytrid ecology. p. 24. Proceedings of *Getting the Jump on Amphibian Disease*, Cairns, Australia, 26-29 August 2000.

Berger, L., Speare, R., Daszak, P.I., Green, D.E., Cunningham, A.A., Goggin, C.L., Slocombe, R., Ragan, M.A., Hyatt, A.D., McDonald, K.R., Hines, H.B., Lips, K.R., Marantelli, G. & Parkes, H. (1998) Chytridiomycosis causes amphibian mortality associated with population declines in the rainforests of Australia and Central America. *Proceedings of the National Academy of Science* **95**: 9031-6.

Berger, L., Speare, R. & Hyatt, A. (1999) Chytrid fungi and amphibian declines: overview, implications and future directions. In 'Declines and Disappearances of Australian Frogs'. (Ed. A. Campbell.) pp. 23-33. (Environment Australia: Canberra.)

Bosch, J., Martinez-Solano, I., & Garcia-Paris, M. (2001) Evidence of a chytrid fungus infection involved in the decline of the common midwife toad (*Alytes obstetricians*) in protected areas of central Spain. *Biological Conservation* **97**:331-337.

Campbell, A. (ed.) (1999) *Declines and disappearances of Australian Frogs*. Environment Australia: Canberra.

Carey, C., Cohen, N. & Rollins-Smith, L. (1999) Amphibian declines: an immunological perspective. *Developmental and Comparative Immunology* **23**: 459-472.

Daszak, P., Berger, L., Cunningham, A.A. Hyatt, A.D., Green, D.E. & Spearc, R. (1999) Emerging Infectious Diseases and Amphibian Population Declines. *Emerging Infectious Diseases* **5**(6): 735-748.

Daszak, P., Cunningham, A.A. & Hyatt, A.D. (2000) Emerging Infectious Diseases of Wildlife –Threats to Biodiversity and Human Health. *Science* **287**: 443-449.

Gillespie, G. & Hines, H. (1999) Status of temperate riverine frogs in south-eastern Australia. In 'Declines and Disappearances of Australian Frogs'. [Ed. A. Campbell], pp. 109-30. Environment Australia: Canberra.)

Gillespie G. R. & Hollis, G. J. (1996) Distribution and habitat of the Spotted Tree Frog, *Litoria spenceri* Dubois (Anura: Hylidae), as an assessment of potential causes of population declines. *Wildlife Research* **23**: 49-75.

Gillespie, G. & Marantelli, G. (2000) The role of the amphibian chytridiomycete fungus in population dynamics of the spotted tree frog (*Litoria spenceri*), a declining riverine species in south-eastern Australia. p. 45. *Proceedings of Getting the Jump on Amphibian Disease*, Cairns, Australia, 26-29 August 2000.

Halliday, T. (1998) A declining amphibian conundrum. *Nature* **394**: 418-419.

Houlahan, J.E., Findlay, C.S., Schmidt, B.R., Meyer, A.H. & Kuzmin, S.L. (2000) Quantitative evidence for global amphibian population declines. *Nature* **404**: 752-755.

Hyatt, M.A., A.D., McDonald, K.R., Hines, H.B., Lips, K.R., Marantelli, G. & Parkes, H. (1998) Chytridiomycosis causes amphibian mortality associated with population declines in the rain forests of Australia and Central America. *Proceedings of the National Academy of Sciences USA*. **95**: 9031-9036.

Kiesecker, J.M., Blaustein, A.R. & Belden, L.K. (2001) Complex causes of amphibian population declines. *Nature* **410**: 681-684.

Laurance, W.F., McDonald, K.R. & Speare, R. (1996) Epidemic disease and the catastrophic decline of Australian rainforest frogs. *Conservation Biology* **77**: 203-12.

Longcore, J.E., Pessier, A.P. & Nichols, D.K. (1999) *Batrachochytrium dendrobatidis* gen. et sp. nov., a chytrid pathogenic to amphibians. *Mycologia* **91**: 219-27.

Mahony, 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. *Australian Zoologist* **30**(2): 237-247.

Mann, R. & Bidwell, J. (1999) Toxicological issues for amphibians in Australia. In Campbell, A. (ed.) (1999) *Declines and disappearances of Australian Frogs*. Environment Australia: Canberra. pp. 185-201.

Marantelli, G. & Hobbs, R. (2000) Disease vectors and the community: from lost frogs to frog friendly gardens – how do we help frogs while containing disease spread? p. 49. *Proceedings of Getting the Jump on Amphibian Disease*, Cairns, Australia, 26-29 August 2000.

McDonald, K. & Alford, R. (1999) A review of declining frogs in Northern Queensland. In Campbell, A. (ed.) (1999) *Declines and disappearances of Australian Frogs*. Environment Australia: Canberra. pp. 14-22.

Morehouse, E.A., James, T.Y., Ganley, A.R.D., Vilgalys, R., Berger, L., Murphy, P.J. & Longcore, J.E. (2003) Multilocus sequence typing suggests the chytrid pathogen of amphibians is a recently emerged clone. *Molecular Ecology* **12**: 395-403.

Morell, V. (1999) Are Pathogens Felling Frogs? *Science* **284**: 728-731.

Nichols, D. K., Lamirande, E.W., Pessier, A.P. & Longcore, J.E. (2001) Experimental transmission of cutaneous chytridiomycosis in dendrobatid frogs. *Journal of Wildlife Diseases* **37**(1): 1-11.

NSW Scientific Committee (2003) *Infection of frogs by amphibian chytrid causing the disease chytridiomycosis* - Final Determination. New South Wales Scientific Committee: Sydney.

Osbourne, W., Hunter, D., & Hollis, G. (1999) Population Declines and Range Contraction in Australian Alpine Frogs. *In* Campbell, A. (ed.) (1999) *Declines and disappearances of Australian Frogs*. Environment Australia: Canberra. pp. 145-158.

Pounds, J.A. (2001) Climate and amphibian declines. *Nature* **410**: 639-640.

Retallick, R. & Dwyer, L. (2000) Using translocations to learn about frog declines and disease. In Proceedings of Getting the Jump on Amphibian Disease. Cairns, Australia 2000 p. 41.

Rollins-Smith, L.A., Carey, C., Longcore, J., Doersam, J.K., Boutte, A., Bruzgal, J.E. & Conlon, J.M. (2002) Activity of antimicrobial skin peptides from ranid frogs against *Batrachochytrium dendrobatidis*, the chytrid fungus associated with global amphibian declines. *Developmental and Comparative Immunology* **26**: 471-479.

Speare, R. (2000) Understanding the pieces of the amphibian disease puzzle. p. 19. *Proceedings of Getting the Jump on Amphibian Disease,* Cairns, Australia, 26-29 August 2000.

Relevant websites: (as of October 2003)

Frogs of Victoria Amphibian Research Centre - http://www.frogs.org.au/frogs/index.html

CSIRO (2003) Researching frog fungus. http://www.csiro.au/index.asp?type=faq&id=Frog%20fungus.

Daszak, P., Cunningham, A.A. & Hyatt, A.D. (2000) Amphibian Chytridiomycosis and emerging infectious diseases of wildlife. http://www.vet.uga.edu/ivcvm/2000/Daszak/Daszak.htm

Nomination of amphibian chytridiomycosis as a 'Key Threatening Process' under the **EPBC Act 1999** http://www.jcu.edu.au/school/phtm/PHTM/frogs/adms/attach7.pdf

NSW Scientific Committee (2003) *Infection of frogs by amphibian chytrid causing the disease chytridiomycosis* - Final Determination: http://www.nationalparks.nsw.gov.au/npws.nsf/Content/Infection+of+frogs+by+amphibian+chytrid+causing+the+disease+chytridiomycosis+key+threatening+process+declaration

Speare, R. (2000) Understanding the pieces of the amphibian disease puzzle. In Proceedings of Getting the Jump on Amphibian Diseases. Cairns, Australia 2000. http://www.jcu.edu.au/school/phtm/PHTM/frogs/speare1.ppt

Speare, R. (2001) Attachment 7: Nomination of amphibian chytridiomycosis as a key threatening process. In 'Developing Management Strategies to Control Amphibian Diseases: Decreasing The Risks Due To Communicable Diseases'. pp 185-208. Report to Environment Australia: Canberra. http://www.jcu.edu.au/school/phtm/PHTM/frogs/adms/scope.htm

Speare, R. & Berger, L. (2000a) Global distribution of chytridiomycosis in amphibians. http://www.jcu.edu.au/school/phtm/PHTM/frogs/chyglob.htm

Speare, R. & Berger, L. (2000b) Chytridiomycosis in amphibians in Australia. http://www.jcu.edu.au/school/phtm/PHTM/frogs/chyglob.htm

Endorsement by the Convenor of the Scientific Advisory Committee **Date**

11/11/03

Dr Mike Clarke
Convenor