



Agreement on the Conservation of Albatrosses and Petrels

Third Meeting of Advisory Committee

VALDIVIA, CHILE, 19 – 22 JUNE 2007

Report of the Taxonomy Working Group to AC3

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AGREEMENT ON THE CONSERVATION OF ALBATROSSES AND PETRELS

REPORT BY THE TAXONOMY WORKING GROUP TO THE ADVISORY COMMITTEE MEETING 3 – VALDIVIA, CHILE 2007

“...it would seem quite legitimate...to quietly despair or yell out loud in anger –
biologists can’t even agree what a species is!”
Onley, D. & Scofield, P. (2007). 'Albatrosses, Petrels and Shearwaters of the World.'

1. Summary

This report presents the decision-making guidelines of the Taxonomy Working Group (Attachment 1) and the application of these guidelines to six pairs of taxa currently listed under Annex 1 (Attachment 2) of the Agreement on the Conservation of Albatrosses and Petrels (ACAP):

1. Buller’s and Pacific Albatrosses (*Thalassarche bulleri/platei*)
2. Northern Royal and Southern Royal Albatrosses (*Diomedea sanfordi/epomophora*)
3. Atlantic and Indian Yellow-nosed Albatrosses (*Thalassarche chlororhynchos/carteri*)
4. Chatham and Salvin’s Albatrosses (*Thalassarche eremita/salvini*)
5. Northern and Southern Giant-petrels (*Macronectes giganteus/halli*)
6. White-chinned and Spectacled Petrels (*Procellaria aequinoctialis/conspicillata*)

We concluded that available data for these taxa do not call for an amendment to the species currently listed under Annex 1 of the Agreement. However, we recognise that data pertinent to this taxonomic process are sometimes meagre and new data may be highly influential. The following taxa are considered to be particularly data-poor and any decisions described here will need to be revisited upon publication of new data:

Buller’s and Pacific Albatrosses
Northern Royal and Southern Royal Albatrosses
Indian and Atlantic Yellow-nosed Albatrosses

We also propose a 2007/2008 Work Programme for the Taxonomy Working Group that includes:

1. a review of the taxonomic status for:
 - a. Black and Westland Petrels
 - b. Tristan and Wandering Albatrosses
 - c. Campbell and Black-browed Albatrosses;
2. a review of relevant literature published since the Working Group’s web-based bibliographic database was last updated in 2005 - new papers will be added to the database; and
3. the establishment of a morphometric and plumage database to facilitate the taxonomic process, the identification of bycatch specimens, and the long-term storage of valuable data.

2. Background

Article IX 6 (b) of the Agreement on the Conservation of Albatrosses and Petrels (ACAP) requires the Advisory Committee to “endorse a standard reference text listing the taxonomy and maintain a listing of taxonomic synonyms for all species covered by the Agreement”. This reflects the current state of flux in the taxonomy of Procellariiformes and, in particular, of albatrosses.

Resolution 1.5 of the First Session of the Meeting of the Parties (MoP1) to ACAP provides for the establishment by the Advisory Committee of a Working Group on the taxonomy of albatross and petrel species covered by the Agreement.

The objective of the Working Group was to establish a transparent, defensible and highly consultative taxonomic listing process. The Scientific Meeting that preceded the first meeting of Parties (MoP1; ScM1; Section 4.3) stated that “...given the importance that species lists have upon conservation policy and scientific communication, taxonomic decisions must be based on robust and defensible criteria. It is important to resolve differences in a scientific and transparent manner with appropriate use of peer-reviewed publications.”

The Terms of Reference for the Taxonomy Working groups are presented in Attachment 3.

3. Introduction

A comprehensive introduction to the taxonomy of albatrosses and petrels was presented in the Report of the Taxonomy Working Group to AC2 (AC2 Doc 11) and, for reference, is presented again in Attachment 4.

The first action for this WG was to agree on a set of guidelines for taxonomic decision-making (Attachment 1). These guidelines are based on those described by Helbig et al. (2002) of the taxonomic sub-committee of the British Ornithologists' Union and justify the adoption of a particular species concept and make the decision-making process transparent. They facilitate the assessment and assimilation of potentially influential studies while guarding against poor science. The guidelines also consider the inevitable limitations of species lists and the benefits of taxonomic stability.

The Scientific Meeting (MOP1; ScM1; Section 4.6) recommended, “...as a first step, [the Taxonomy] Working Group...should aim to reach consensus about the three main contentious albatross species splits; namely *Diomedea antipodensis/gibsoni*, *Thalassarche cauta/steady* and *T. bulleri/platei*.”

In the Report of the Taxonomy Working Group to AC2 (AC2 Doc 11) we summarised and assessed the scientific data relevant to these three taxa groups and suggested that data does not currently support the recognition of Gibson's and Antipodean Albatrosses (*Diomedea antipodensis/gibsoni*) or Buller's and Pacific Albatrosses (*Thalassarche bulleri/platei*) at the specific level. We did however recognise that data suggest Shy and White-capped Albatrosses (*Thalassarche cauta/steady*) are divergent and diagnosable

and therefore, following the taxonomic guidelines, warrant recognition at the specific level.

These recommendations were endorsed by the ACAP Advisory Committee and Resolution 2.5 of Second Meeting of Parties (MoP2) removed *Diomedea gibsoni* and *Thalassarche platei* from Annex 1 of the Agreement. The current list of taxa recognised by the ACAP under Annex 1 of the Agreement is presented in Attachment 2.

The Work Programme of the Taxonomy Working Group and agreed by the Advisory Committee at AC2 in 2006 is presented in Attachment 5. This work programme recommended that the specific status of seven pairs of taxa should be reviewed before AC3. The available data and taxonomic decisions for these species are presented below.

4. Review of taxonomic data and justification of taxonomic decisions:

For convenience, taxa are sometimes referred to by their specific names only. For example, Northern and Southern Giant-petrels are referred to as *giganteus* and *halli* respectively.

4.1. Buller's and Pacific Albatrosses

These taxa were reviewed in the Report of the Taxonomy Working Group to AC2 (AC2 Doc 11). They were retained on the work programme in anticipation of new genetic data. As yet no new data have been published so these taxa will not be considered further here.

4.2. Northern and Southern Royal Albatrosses

Recent taxonomic history

The Northern form of the Royal Albatross was formally described by Murphy (1917) but this taxon has generally been treated as a subspecies of (*Diomedea epomophora sanfordi*) along with the Southern Royal Albatross (*Diomedea epomophora epomophora*) (e.g. Marchant & Higgins 1990). More recently Robertson & Nunn (1998) resurrected the specific status of these taxa although they provided few data to substantiate their case.

Primary publications or reviews of data relevant to the taxonomy of Northern and Southern Royal Albatrosses

1. **Harrison (1979; 1985)** described age-based criteria for differentiating *epomophora* and *sanfordi* at sea.
2. **Marchant & Higgins (1990)** summarised the available morphometric data for *sanfordi* and *epomophora*. They show strong morphological differentiation between the taxa.
3. **Nunn et al. (1996)** published sequence data from the mitochondrial cytochrome b gene for *sanfordi* only.
4. **Nunn & Stanley (1998)** published sequence data from the mitochondrial cytochrome b gene for both *epomophora* and *sanfordi* but made no taxonomic inferences.
5. **Robertson & Nunn (1998)** identified *epomophora* and *sanfordi* as terminal taxa and suggested they be recognised as separate species.

6. **Robertson (1998)** and later summarised by Taylor (2000) reported pairings of *epomophora* and *sanfordi* at Taiaroa Head and Enderby Island (Auckland Islands).
7. **Penhallurick & Wink (2004)** showed the divergence between the available cytochrome b sequences for *epomophora* and *sanfordi* (a single individual for each taxon) to be only 0.0009%. These authors argued that although these taxa are divergent, because the level of divergence is “smaller than... ‘good’ species of albatross,” they should be classified as subspecies.
8. **Rheindt & Austin (2005)** challenged Penhallurick & Wink (2004) on their methods of analysis and their interpretation of species concepts. They suggested because Penhallurick & Wink (2004) “use their own divergence estimates to override morphological, behavioural and genetic studies that have already established the species status of a number of taxa in question” they fail to follow their adopted multidimensional species concept.

Assessment of diagnosability (cf. Attachment 1; Section3)

Based on data provided in the studies described above:

- A. Same age/sex individuals of *epomophora* and *sanfordi* **can** be distinguished by one or more qualitative differences.
- B. Same age/sex individuals of *epomophora* and *sanfordi* **can** be distinguished by a complete discontinuity in one or more continuously varying characters.
- C. Same age/sex individuals of *epomophora* and *sanfordi* **can** be distinguished by a combination of two or three functionally independent characters.

Decision

These taxa meet the diagnosability criteria described in Attachment 1. There are consistent plumage and morphological differences between these taxa that allow them to be distinguished at sea. The little genetic data available suggest divergence but clearly these taxa are very closely related and there is some evidence for contemporary gene flow. Currently, we recommend that these taxa continue to be recognised as separate species, namely:

Diomedea epomophora (Southern Royal Albatross)

Diomedea sanfordi (Northern Royal Albatross)

This follows Robertson & Nunn (1998) and concurs with recent wide-ranging works on Procellariiformes (Brooke 2004; Onley & Scofield 2007) and the current taxonomy of BirdLife International (2007).

Comments

This is clearly this is a case where more data are required. Phylogenetic, phylogeographic and population genetic data from each of the main breeding islands (Taiaroa Head and the Chatham, Campbell and Auckland Islands) are required and given the observed cases of hybridisation such data may be highly influential. More detailed morphometric and behavioural data would also be desirable as would quantitative analyses of plumage and plumage maturation. Upon production of these data this decision will need to be revisited.

4.3. Indian Yellow-nosed and Atlantic Yellow-nosed Albatrosses

Recent taxonomic history

Until recently the Atlantic and Indian Ocean populations of Yellow-nosed Albatross *Thalassarche chlororhynchos* were treated as a single species, without even the recognition of sub-specific differences (e.g. Mayr & Cottrell 1979). Brooke et al. (1980) rightly pointed out the consistent plumage differences between adults of the two populations, recognising the Indian Ocean population as *bassi*. Subsequently, Robertson (2002) pointed out that Brooke et al. (1980) were incorrect in assuming the juvenile type of *carteri*, which predated *bassi*, could not be ascribed to a taxon. By showing that the type of *carteri* also is from the Indian Ocean population, it became the appropriate name for this population. Robertson & Nunn (1998) classified these taxa as separate species based on phylogenetic data presented by Nunn et al. (1996). The recognition of two species of Yellow-nosed Albatross has been widely adopted (Shirihai 2002; Brooke 2004; Onley & Scofield 2007) but acceptance of this classification is not universal (e.g. Penhallurick & Wink 2004).

Primary publications or reviews of data relevant to the taxonomy of Indian and Atlantic Yellow-nosed Albatrosses

1. **Brooke et al. (1980)** presented morphometric data collected from Gough Island (n=27 *chlororhynchos*) and Prince Edward Island (n=15 *carteri*). These data were supplemented by PGR (unpublished data). Analyses suggest *chlororhynchos* has a significantly shorter bill, and longer minimum bill depth (Table 1), confirming the perception given in the field that *carteri* has a relatively longer, more slender bill (Brooke et al. 1980). The wing of *chlororhynchos* is also longer (Table 1), but variances are large due to wear, and there is little difference in the maximum wing lengths recorded for each taxon (529 mm for *chlororhynchos* and 520 for *carteri*).

Table 1. Morphometric data from *T. chlororhynchos* and *T. carteri* (mean±SD, n). Data compiled from Brooke et al. 1980 and PGR unpubl. data.

Measure	<i>chlororhynchos</i>	<i>carteri</i>	Significance (t-test; two tailed)
Wing	501.6±11.8 (29)	491.1±12.5 (21)	t=3.02, P=0.004
Tarsus	82.7±2.6 (29)	81.7±2.8 (21)	t=1.29, NS
Culmen	114.9±3.9 (30)	118.9±4.2 (33)	t=3.80, P<0.001
Bill depth at gonys	25.3±1.3 (30)	25.4±1.1 (33)	t=0.59, NS
Minimum bill depth	23.3±1.8 (29)	22.4±1.1 (32)	t=2.27, P=0.027

2. **Marchant & Higgins (1990)** describe the plumage and structural features separating the two subspecies and these are summarised in Table 2. All features refer to birds in adult plumage, but these authors suggest the black eye patch is distinctly larger among juvenile and immature *chlororhynchos* than it is in *carteri*.
3. **Nunn et al. (1996) and Nunn & Stanley (1998)** presented sequence data from a single *chlororhynchos* from Gough Island and one *carteri* from an unknown location (probably Amsterdam Island). Sequence divergence between these specimens was less than 1%.

Table 2. Plumage and structural features separating the two yellow-nosed albatrosses *T. chlororhynchos* and *T. carteri* (after Marchant & Higgins 1990; Robertson 2002).

Character	<i>T. chlororhynchos</i>	<i>T. carteri</i>
Head and neck	pearly grey except for white fore-crown	white; grey wash only on cheeks and in fresh plumage
Lores	blackish; extensive reaching below eye	paler grey; much smaller, barely extending below eye
Cheek	distinct white crescent	barely visible white crescent
Shape of bill strip	usually rounded	pointed
Culminicorn	base widens above nostrils	base tapers above nostrils
Naricorn	sides of base convex	sides of base straight

4. **Robertson & Nunn (1998)** suggested that *chlororhynchos* and *carteri* should be recognised as distinct species probably based on known morphological differences and distinct cytochrome b sequences (Nunn & Stanley 1998) but little justification was provided to support this contention. However, Robertson & Nunn (1998) emphasised that their paper was primarily designed to stimulate debate and that formal assessment of species limits among albatrosses requires comparison of sequence data from all breeding colonies.
5. **Bourne (2002)** pointed out that differences in morphology between these taxa are subtle.
6. **Penhallurick & Wink (2004)** noted that the difference in cytochrome b sequences is only 0.35%, appreciably less than that between ‘well defined’ species of albatrosses (all >1%) and suggested that these taxa should not be recognised at the specific level.
7. **Rheindt & Austin (2005)** challenged Penhallurick & Wink (2004) on their methods of analysis and their interpretation of species concepts.

Assessment of diagnosibility (cf. Attachment 1; Section3)

Based on data provided in the studies described above:

- A. Same age/sex individuals of *chlororhynchos* and *carteri* **can** be distinguished by one or more qualitative differences.
- B. Same age/sex individuals of *chlororhynchos* and *carteri* **cannot** be distinguished by a complete discontinuity in one or more continuously varying characters.
- C. Same age/sex individuals of *chlororhynchos* and *carteri* **can** be distinguished by a combination of two or three functionally independent characters.

Decision

These taxa meet the diagnosibility criteria described in Attachment 1. There are consistent plumage and structural differences that allow the two yellow-nosed albatrosses to be readily distinguished at sea, at least in adult plumage (Reid & Carter 1988; Hockey et al. 2005), and they can be distinguished in the hand at all ages given differences in bill morphology (Robertson 2002). Given this and a desire for a stable taxonomy (Helbig et al. 2002) we recommend that these taxa continue to be recognised as separate species, namely:

Thalassarche chlororhynchos (Atlantic Yellow-nosed Albatross)

Thalassarche carteri (Indian Yellow-nosed Albatross)

This follows Robertson & Nunn (1998) and concurs with recent wide-ranging works on Procellariiformes (Brooke 2004; Onley & Scofield 2007) and the current taxonomy of BirdLife International (2007).

Comments

Clearly this is a case where more data are needed and further data may require this decision to be revisited. Phylogenetic, phylogeographic and population genetic data from each of the main breeding islands (Tristan, Gough, Prince Edward, Crozets, and Amsterdam Island) are required. The at-sea ranges of the two taxa overlap off southern Africa (Hockey et al. 2005), and *chlororhynchos* have been recorded visiting Amsterdam Island (Roux & Martinez 1987), so the possibilities of contemporary migration and inter-breeding need to be explored.

4.4. Chatham and Salvin's Albatrosses

Recent taxonomic history

Prior to Robertson & Nunn (1998) these taxa were classified as separate subspecies; Salvin's Albatrosses (*Thalassarche cauta salvini*) and Chatham Albatrosses (*T. c. eremita*) within the Shy Albatross (*Thalassarche cauta*) complex (e.g. Marchant & Higgins 1990). Robertson & Nunn (1998) elevated all four subspecies within this section of the genus to specific status.

Primary publications or reviews of data relevant to the taxonomy of Chatham and Salvin's Albatrosses

1. **Nunn et al. (1996)** only included DNA sequence data from *T. cauta*, but provided convincing justification establishment of genus *Thalassarche* and for the placement of Shy Albatrosses within the genus. Analyses of molecular data for *salvini* and *eremita* were later presented in Nunn & Stanley (1998) placing them as a sister group to *T. cauta*.
2. **Robertson & Nunn (1998)** presented a well resolved phylogeny for full mitochondrial cytochrome-b DNA sequences. Their unweighted maximum parsimony tree shows *cauta* paired with *stedi* and together with *salvini* plus *eremita* forming a sister group to all other *Thalassarche* taxa. These authors justified the recognition of Salvin's and Chatham Albatrosses as full species on the grounds that they are morphologically distinct, but without giving details.
3. **Onley & Bartle (1999)** showed that plumage characters can be used to divide the *cauta/stedi* pair from *salvini/eremita*. Adult *salvini* and *eremita* are distinct, with the latter being much darker in colour with much brighter yellow bill. However, the young of both *salvini* and *eremita* have dark plumage on the head and black bills and cannot be distinguished easily.
4. **Penhallurick & Wink (2004)** analysed the same dataset and noted that the genetic distance between *cauta* and *salvini/eremita* (~1.0%) was around four times as large as that between *salvini* and *eremita* (0.26%), but still lumped all three together as subspecies in a *T. cauta* complex. The author's phylogenetic methodology and their application of species definitions have been extensively criticised by Rheindt & Austin (2005).
5. **van Bekkum (2004)** showed genetic assignment tests show that *cauta* and *stedi* are easily and reliably separable (reciprocal misclassification rates are only 3 and 5%). Similarly, *salvini* can be distinguished fairly well from other *Thalassarche*

taxa including *eremita* (figures; 26/30 assigned to type with 2 misclassified as *eremita*). However, few samples are available for *eremita* (N = 8).

6. **Abbott & Double (2003a)** showed mtDNA control region divergence to be 2.9% between *salvini* and *eremita* compared with 1.8% between *cauta* and *steadii* and a mean value of 7.0% between members of these two pairs.

Assessment of diagnosibility

Based on data provided in the studies described above:

Assessment of diagnosibility (cf. Attachment 1; Section3)

Based on data provided in the studies described above:

- A. Same age/sex individuals of *T. eremita* and *T. salvini* **can** be distinguished by one or more qualitative differences.
- B. Same age/sex individuals of *T. eremita* and *T. salvini* **can** be distinguished by a complete discontinuity in one or more continuously varying characters.
- C. Same age/sex individuals of *T. eremita* and *T. salvini* **can** be distinguished by a combination of two or three functionally independent characters.

Decision

These taxa satisfy the diagnosibility criteria described in Attachment 1. Given this and a desire for a stable taxonomy (Helbig et al. 2002) we recommend that these taxa continue to be recognised as separate species. These taxa can be easily separated using both qualitative and quantitative traits (mitochondrial DNA sequences, microsatellites; head plumage and bill coloration). No gene flow has been reported between these two taxa. We, therefore, recommend that these taxa continue to be recognised as full species, namely:

Thalassarche salvini (Salvin's Albatross)

Thalassarche eremita (Chatham Albatross)

This follows Robertson & Nunn (1998) and concurs with recent wide-ranging works on Procellariiformes (Brooke 2004; Onley & Scofield 2007) and the current taxonomy of BirdLife International (2007).

Comments

These studies and the analysis previously presented to AC2 clearly show that the four members of this subgroup of the *Thalassarche* have diverged from one another very recently in evolutionary terms, but the fact that they are divergent is indisputable. They are best viewed as forming two pairs each with members that are more closely related to each other than either is to either member of the other pair. Quantitative differences in DNA sequences from two mitochondrial DNA loci represent relative divergence times. Based on the data highlighted above these appear to be three to four fold greater for the split between the pairs than for the origin(s) of the four individual taxa.

Divergence has not been consistently manifested in plumage differences immediately apparent to human observers. This can result in subjective bias, perhaps explaining why many observers are more reluctant to recognise *cauta* and *steadii* at specific level than *eremita* and *salvini*.

4.5. Northern and Southern Giant-petrels

Recent taxonomic history

Bourne & Warham (1966) first described the differences between Southern Giant Petrel (*Macronectes giganteus*) and the Northern Giant Petrel (*M. halli*) noting *giganteus*: nests further south; has a white plumage phase; has a pale green bill tip; breeds in open in colonies; and breeds about six weeks later than *halli*. Although these distinctions are generally clear, hybrids are known (Hunter 1983). Nunn & Stanley (1998) presented genetic evidence that suggested the evolutionary separation of the two species is fairly recent and this led Penhallurick & Wink (2004) to recommend that the taxa be recognised as subspecies.

Primary publications or reviews of data relevant to the taxonomy of Northern and Southern Giant-petrels

1. **Bourne & Warham (1966)** first proposed the split of the two taxa based on distribution, nesting habits and seasonality, bill colour and the presence of a white morph in *giganteus*.
2. **Voisin & Bester (1981)** highlighted peculiarities of the Gough population, provisionally assigned to *giganteus*.
3. **Hunter (1983)** noted interbreeding at a low frequency (2-3%) on South Georgia.
4. **Warham (1990)**, in a definitive work on the Procellariiformes which generally inclined towards 'lumping' rather than 'splitting', retained the two species.
5. **Nunn & Stanley (1998)** provided the first molecular evidence. The taxa were clearly very closely related, a point never disputed.
6. **González-Solís et al. (2000)**, based on satellite tracking data, reported little evidence for niche-partitioning between the sympatric *giganteus* and *halli* nesting on Bird Island, South Georgia.
7. **González-Solís et al. (2002)**, based on analyses of metals and selenium in blood, showed geographic and dietary partitioning of the sympatric *giganteus* and *halli* nesting on Bird Island and showed *halli* to be a dietary specialist.
8. **Penhallurick & Wink (2004)** noted the limited genetic (0.61%; cytochrome b) and amino acid (0.26%) differentiation and the low incidence of interbreeding and argued for merging the taxa. To their way of thinking, this carried more weight than the considerable body of evidence that show these taxa nest in the same places, but use different sites and breed at different times with little or no interbreeding.
9. **Rheindt & Austin (2005)** savagely criticised Penhallurick & Wink (2004) and considered the low level of interbreeding was by no means incompatible with according full species status to the two taxa, and indeed was lower than that between many other taxon pairs which are unhesitatingly accepted as species.
10. **Techow (2007)** provided further molecular evidence, both from mitochondrial cytochrome b and nuclear microsatellite markers. Despite the unexpected complication that *giganteus* was paraphyletic, the essential genetic separation of *giganteus* and *halli* was confirmed, supporting the retention of two species. The problematic birds from the Falklands and Gough clearly belonged to the Southern Giant Petrel clade. However, it must be noted that these data have yet to be published.

Assessment of diagnosability

Based on data provided in the studies described above:

- A. Same age/sex individuals of *giganteus* and *halli* **can** be distinguished by one or more qualitative differences.
- B. Same age/sex individuals of *giganteus* and *halli* **can** be distinguished by a complete discontinuity in one or more continuously varying characters.
- C. Same age/sex individuals of *giganteus* and *halli* **can** be distinguished by a combination of two or three functionally independent characters.

Decision

These taxa are genetically, morphologically and behaviourally distinct and show little propensity to interbreed despite breeding sympatrically. Persuasive genetic data has been collected but has yet to be published. Currently, these taxa should be retained as two full species, namely:

Southern Giant Petrel *Macronectes giganteus*

Northern Giant Petrel *Macronectes halli*

This classification concurs with recent wide-ranging works on Procellariiformes (Brooke 2004; Onley & Scofield 2007) and the taxonomy of BirdLife International (2007).

4.6. White-chinned and Spectacled Petrels

Recent taxonomic history

The Spectacled Petrel currently only breeds on the plateau of Inaccessible Island in the Tristan da Cunha archipelago (Ryan 1998; Ryan & Moloney 2000; Ryan et al. 2006) and until recently was treated as either a subspecies (*Procellaria aequinoctialis conspicillata*) or morph of the widespread White-chinned Petrel *Procellaria aequinoctialis* (Rowan et al. 1951). Ryan (1998) presented evidence to suggest that the Spectacled Petrel should be treated as a distinct species on the basis of vocal, plumage and structural differences and this was generally accepted by the conservation community, although no genetic data were available when accepted (BirdLife International 2004b).

Primary publications or reviews of data relevant to the taxonomy of White-chinned and Spectacled Petrels

1. **Rowan et al. (1951)** and **Hagen (1952)** reported that the extent of the white spectacle is variable but apparently always present.
2. **Ryan (1998)** presented comprehensive evidence to suggest that the Spectacled Petrel should be treated as a distinct species on the basis of distinct vocalisations, plumage and morphology.
3. **Techow (2007)** conducted a detailed study of the phylogeography of the White-chinned Petrel complex, using both cytochrome b and microsatellite markers and revealed strong phylogenetic and population genetic differentiation between *aequinoctialis* and *conspicillata*. However, it must be noted that this information is extracted from a PhD thesis and these findings have yet to be published.

Assessment of diagnosability

Based on data provided in the studies described above:

- A. Same age/sex individuals of *aequinoctialis* and *conspicillata* **can** be distinguished by one or more qualitative differences.

- B. Same age/sex individuals of *aequinoctialis* and *conspicillata* **cannot** be distinguished by a complete discontinuity in one or more continuously varying characters.
- C. Same age/sex individuals of *aequinoctialis* and *conspicillata* **can** be distinguished by a combination of two or three functionally independent characters.

Decision

Available published data suggest *aequinoctialis* and *conspicillata* are diagnosable. Also, unpublished data from mitochondrial and nuclear markers indicate that the taxa are divergent and genetically isolated but the strength of these data will be considered further when published. Currently we recommend that these taxa should be recognised as species:

White-chinned Petrel *Procellaria aequinoctialis*

Spectacled Petrel *Procellaria conspicillata*

This classification concurs with recent wide-ranging works on Procellariiformes (Brooke 2004; Onley & Scofield 2007) and the taxonomy of BirdLife International (2007).

Comment

The Working Group will reconsider this decision upon formal publication of the genetic data described above.

4.7. Black and Westland Petrels

A summary of taxonomic data for these taxa could not be completed in time for this meeting. They will be included in the Work Programme for 2007/2008.

5. Other items on the 2006/2007 Work Programme

The Working Group's web site and bibliographic database has been removed from the servers of the Australian National University and is currently hosted by a commercial web service (www.acaptaxonomy.net). This site will be moved to within the ACAP website when the Secretariat has also settled on a new web host.

In 2006/2007 the Working Group did not assess the utility of the subspecies rank for ACAP or investigate the development of guidelines for the recognition of subspecific status. Also, the WG did not develop a morphological and plumage database. These tasks have been moved to the 2007/2008 Work Programme.

To ensure progress on such tasks in 2007/2008, we request that the Working Group's budget and the Secretariat project management procedures are made clear to the Working Group Convenor as soon after AC3 as possible.

6. The proposed 2007/2008 Work Programme for the ACAP Taxonomy Working Group

This Taxonomy Working Group was established to develop a practical, defensible and consistent list of species for ACAP and also summarise available data on the listed species. We will therefore review the remaining taxa listed by ACAP that have been the subject of recent taxonomic debate (see below).

As agreed at AC2 the Working Group will review the rank of subspecies in procellariiform seabirds (see review by Phillimore & Owens 2006) and, if considered appropriate, develop taxonomic guidelines for the recognition of such taxa.

The Working Group will continue to maintain its bibliographic database and conduct a review of relevant literature published since the database was last updated in 2005.

The Working Group will establish a morphometric and plumage database to facilitate the taxonomic process, the identification of bycatch specimens, and the long-term storage of valuable data.

The 2007/2008 Work Programme for the Taxonomy Working Group

Action	Completed by	Responsibility
Review the evidence supporting the specific status of the following taxa: <ul style="list-style-type: none"> • Black Petrels and Westland Petrels • Tristan and Wandering Albatross • Amsterdam and Wandering Albatross • Campbell and Black-browed Albatross 	2007/2008	WG Convenor
Migrate the WG's web site to ACAP Secretariat	2007/2008	WG Convenor
Assess the utility of the subspecies rank for ACAP purposes and if appropriate develop guidelines for the recognition of subspecific status	2007/2008	WG Convenor
Construct a morphological and plumage database, then canvas for, collate, archive and summarise available data	2007/2008	WG Convenor
Maintain the WG's bibliographic database of published scientific papers relevant to the taxonomic status of ACAP listed taxa	2007/2008	WG Convenor
Develop and provide advice to AC on the construction and maintenance of species lists as appropriate	Ongoing	WG
Provide annual reports to AC on WG activities	2007/2008	WG Convenor
Draft resolutions (when necessary) for amendments to the species list in Annex 1 of the Agreement	Ongoing	AC

ATTACHMENT 1

GUIDELINES FOR THE IDENTIFICATION OF SPECIES BOUNDARIES AMONG TAXA LISTED BY THE AGREEMENT ON THE CONSERVATION OF ALBATROSSES AND PETRELS (ACAP)

TAXONOMIC WORKING GROUP OF ACAP

1. Introduction

Resolution 1.5 of the First Session of the Meeting of the Parties (MOP1) to ACAP provides for the establishment by the Advisory Committee of a Working Group on the taxonomy of albatross and petrel species covered by the Agreement.

The objective of this Working Group (WG) is to establish a transparent, defensible and highly consultative taxonomic listing process. The Scientific Meeting (MOP1; ScM1; Section 4.3) stated that "...given the importance that species lists have upon conservation policy and scientific communication, taxonomic decisions must be based on robust and defensible criteria. It is important to resolve differences in a scientific and transparent manner with appropriate use of peer-reviewed publications."

The guidelines to identify species boundaries among taxa listed by ACAP are listed below. These guidelines are largely based on those presented by Helbig et al. (2002). This document should not be considered an original piece of work but an adaptation of the guidelines presented by Helbig et al. (2002).

It is worth recalling the following paragraph written by Helbig et al. (2002) when reading these guidelines:

"No species concept so far proposed is completely objective or can be used without the application of judgement in borderline cases. This is an inevitable consequence of the artificial partitioning of the continuous processes of evolution and speciation into discrete steps. It would be a mistake to believe that the adoption of any particular species concept will eliminate subjectivity in reaching decisions."

2. Species concepts

Helbig et al. (2002) adopt the General Lineage Concept (GLC: de Queiroz 1998, 1999) a concept very similar to the Evolutionary Species Concept (ESC: Mayden 1997) but stress that "differences between concepts are largely a matter of emphasis" and that the tenets of other common concepts such as the Biological Species Concept, the Phylogenetic Species Concept (PSC: Cracraft 1983) and the Recognition Species Concept are largely encompassed by the GLC.

The General Lineage Concept defines species as:

"...population lineages maintaining their integrity with respect to other lineages through time and space; this means the species are diagnosably different (otherwise we could not recognize them), reproductively isolated

(otherwise they would not maintain their integrity on contact) and members of each (sexual) species share a common mate recognition and fertilization system (otherwise they would not be able to reproduce).” (Helbig et al. 2002)

Helbig et al. (2002) state that to produce a practical taxonomy for West Palaearctic birds the species definition must only include taxa “for which we are reasonably certain that they will retain their integrity no matter what other taxa they encounter in the future.” Helbig et al. (2002) therefore poses two questions:

1. are the taxa diagnosable?
2. are the taxa likely to retain their genetic and phenotypic integrity in the future?

The WG considers the second criterion difficult or impossible to apply to predominantly allopatric taxa such as procellariiform seabirds. The WG therefore restrict its considerations to only the first of the two questions posed by Helbig et al. (2002) in order to delimit species.

By adopting this strategy the WG applies the less stringent form of the GLC (de Queiroz 1998; de Queiroz 1999) and ESC (Wiley 1978) which recognise species that are currently maintaining their genetic and phenotypic integrity but “do not require species to maintain their integrity in the future” (Helbig et al. 2002).

Below we list a set of guidelines the WG will use to decide if taxa are diagnosable and if they therefore warrant specific status.

3. Guidelines to identify species (Diagnosibility)

3.1. Taxon diagnosis is based on characters or character states. Characters used in diagnosis must be considered, or preferably shown, to have a strong genetic (heritable) component and not likely to be the product of environmental differences. Characters known to evolve rapidly in response to latitude must be considered less informative e.g. morphometrics, timing of breeding and moult patterns.

3.2. In the assessment of diagnostic characters the WG, whenever possible, will only consider primary data published in peer reviewed journals. Conclusions drawn by such studies must be supported by appropriate statistical analyses. Once established the Taxonomy WG will aim to maintain the stability of the ACAP List of Taxa. Modifications to the List will only be considered when a study published in a peer-reviewed journal suggests change.

3.3. As stated by Helbig et al. (2002), taxa are diagnosable if:

A) “Individuals of at least one age/sex can be distinguished from the same age/sex class of all other taxa by at least one qualitative difference. This means that the individuals will possess one or more discrete characters that members of the other taxa lack. Qualitative differences refer to presence/absence of a feature (as opposed to a discontinuity in a continuously varying character).”

B) “At least one age/sex class is separated by a complete discontinuity in at least one continuously varying character (e.g. wing length) from the same age/sex class of

otherwise similar taxa. By complete discontinuity we mean that there is no overlap with regard to the character in question between two taxa.” To detect a discontinuity the number of individuals compared should be based on sound judgment.

C) “If there is no single diagnostic character we regard a taxon as statistically diagnosable if individuals of at least one age/sex class can be clearly distinguished from individuals of all other taxa by a combination of two or three functionally independent characters.” Body measurements are not considered independent characters.

A useful example here is the one presented by Helbig et al. (2002). *Larus michahellis* and *L. armenicus* “can be distinguished by a combination of wing-tip pattern, darkness of mantle and mtDNA haplotypes, although none of these characters is diagnostic on its own.”

3.4. Because of the difficulties assessing reproductive isolation in allopatric taxa Helbig et al. (2002) apply more stringent criteria to allopatric than sympatric taxa. They suggest that allopatric taxa should be recognised as species only if “they are fully diagnosable in each of *several* discrete or continuously variable characters relating to different function contexts, e.g. structural features, plumage colours, vocalisations, DNA sequences, and the sum of the character differences corresponds to or exceeds the level of divergence seen in related species that exist in sympatry.”

ATTACHMENT 2

SPECIES CURRENTLY LISTED UNDER ANNEX 1 OF THE AGREEMENT ON THE
CONSERVATION OF ALBATROSSES AND PETRELS (ACAP)

FAMILY DIOMEDEIDAE ALBATROSSES

1	<i>Diomedea exulans</i>	Wandering Albatross
2	<i>Diomedea dabbenena</i>	Tristan Albatross
3	<i>Diomedea antipodensis</i>	Antipodean Albatross
4	<i>Diomedea amsterdamensis</i>	Amsterdam Albatross
5	<i>Diomedea epomophora</i>	Southern Royal Albatross
6	<i>Diomedea sanfordi</i>	Northern Royal Albatross
7	<i>Phoebastria irrorata</i>	Waved Albatross
8	<i>Thalassarche cauta</i>	Shy Albatross
9	<i>Thalassarche steadi</i>	White-capped Albatross
10	<i>Thalassarche salvini</i>	Salvin's Albatross
11	<i>Thalassarche eremita</i>	Chatham Albatross
12	<i>Thalassarche bulleri</i>	Buller's Albatross
13	<i>Thalassarche chrysostoma</i>	Grey-headed Albatross
14	<i>Thalassarche melanophrys</i>	Black-browed Albatross
15	<i>Thalassarche impavida</i>	Campbell Albatross
16	<i>Thalassarche carteri</i>	Indian Yellow-nosed Albatross
17	<i>Thalassarche chlororhynchos</i>	Atlantic Yellow-nosed Albatross
18	<i>Phoebetria fusca</i>	Sooty Albatross
19	<i>Phoebetria palpebrata</i>	Light-mantled Albatross

FAMILY PROCELLARIIDAE - PETRELS

20	<i>Macronectes giganteus</i>	Southern Giant-petrel
21	<i>Macronectes halli</i>	Northern Giant-petrel
22	<i>Procellaria aequinoctialis</i>	White-chinned Petrel
23	<i>Procellaria conspicillata</i>	Spectacled Petrel
24	<i>Procellaria parkinsoni</i>	Black Petrel
25	<i>Procellaria westlandica</i>	Westland Petrel
26	<i>Procellaria cinerea</i>	Grey Petrel

ATTACHMENT 3

WORKING GROUP TO REVIEW THE TAXONOMY OF ALBATROSSES AND PETRELS LISTED ON ANNEX I OF THE AGREEMENT

TERMS OF REFERENCE

Article IX 6 (b) of the Agreement on the Conservation of Albatrosses and Petrels (ACAP) requires the Advisory Committee to “endorse a standard reference text listing the taxonomy and maintain a listing of taxonomic synonyms for all species covered by the Agreement”. This reflects the current state of flux in the taxonomy of Procellariiformes and, in particular, of albatrosses.

Resolution 1.5 of the First Session of the Meeting of the Parties (MoP1) to ACAP provides for the establishment by the Advisory Committee of a Working Group on the Taxonomy of albatross and petrel species covered by the Agreement.

The terms of reference for the group are to:

1. establish a transparent, defensible and highly consultative listing process for the recognition of taxa of albatrosses and petrels listed under Annex 1 of the Agreement.
2. review the specific status of all taxa of albatrosses and petrels listed under Annex 1 of the Agreement;
3. collate and maintain a bibliographic database for published scientific papers relevant to the taxonomy of ACAP listed species;
4. develop and maintain a morphometric database of albatrosses and petrels to assist in taxonomic assessments and ensure long-term storage of valuable data in accordance with agreed data confidentiality arrangements;
5. report to the Meeting of Parties through the Advisory Committee on taxonomic assessments as appropriate.

ATTACHMENT 4

INTRODUCTION TO THE TAXONOMY OF ALBATROSSES AND PETRELS

Conservation policy and scientific communication depend heavily on species lists because such lists are considered accurate representations of contemporary biodiversity (Isaac et al. 2004). Species lists influence conservation policy and must therefore reflect robust, thoughtful and defensible taxonomic decisions that were based on a thorough assessment of all relevant data. Currently, species lists for albatrosses and petrels lack consensus and this highlights the need for the Parties to the Agreement for the Conservation of Albatrosses and Petrels (ACAP) to address this issue.

The taxonomy of albatrosses and petrels has always been problematic. Over 80 albatross taxa have been formally described since the mid 1700s (Robertson & Nunn 1998) often based on specimens collected at sea that could not be assigned to breeding locations. As knowledge of breeding locations and plumage maturation improved many of these 'new taxa' were recognised to be previously described species. This in turn led to prolonged debates over the number of species and the precedence of scientific and common names (e.g. Medway 1993; Robertson & Nunn 1998; Robertson & Gales 1998; Robertson 2002).

The identification of species boundaries among albatrosses and petrels is further confounded by three other factors. First, Procellariiformes spend most of their time at sea and often breed in remote locations. Thus studies of these species are few and data on the breeding behaviour, at-sea distribution and foraging ecology of most species are lacking (Brooke 2004). Second, strong natal philopatry is thought to be characteristic of most petrels (Warham 1990). This precludes the recognition of genuine physiological or behavioural barriers to gene flow because contact between individuals from disparate populations is rare. Third, Procellariiformes (and albatrosses in particular) show unusually low levels of genetic divergence even between what appear to be very different species (Nunn et al. 1996; Nunn & Stanley 1998). This inevitably reduces the power of genetic studies to delineate species boundaries among more closely-related taxa (Burg & Croxall 2001; Abbott & Double 2003a; Burg & Croxall 2004). But our understanding of albatross and petrel species is constantly improving. New data from long-term demographic studies (e.g. Weimerskirch et al. 1997; Croxall et al. 1998; Cuthbert et al. 2003a; Nel et al. 2003), from studies of foraging ecology through the application of satellite tracking technology (e.g. González-Solís et al. 2000; Weimerskirch et al. 2000; Hedd et al. 2001; BirdLife International 2004a; Xavier et al. 2004), molecular genetic analyses (e.g. Burg & Croxall 2001; Abbott & Double 2003b, a; Burg & Croxall 2004) and morphometric analyses (e.g. Cuthbert et al. 2003b; Double et al. 2003) are all likely to influence the taxonomic decision-making process and potentially the content of species lists.

Much of the present taxonomic confusion surrounding albatrosses followed the publication of a phylogenetic study by Nunn et al. (1996). Prior to this study the number of albatross species was considered to be 14. However, using data from Nunn et al. (1996) and other behavioural and morphometric data, Robertson & Nunn (1998) proposed a new 'interim' taxonomy which recognised 24 albatross species. Unfortunately the taxonomic decisions presented in their book chapter were not always

supported by published, peer-reviewed scientific data and thus much controversy has surrounded the decisions therein. Following Robertson & Nunn's publication there has been no consensus over the number of albatross species among scientists, governments or conservation organisations. For example, of the two most recent books that discuss albatross taxonomy, one described 24 species (Shirihai 2002) whereas the other recognised only 21 (Brooke 2004). Similarly, Birdlife International lists 21 albatross species (www.birdlife.net) whereas the preliminary ACAP species lists are based on two taxonomies of 14 and 24 species (www.acap.aq). Only recently Penhallurick & Wink (2004) reviewed the genetic data published by Nunn et al. (1996) and argued the data supported the recognition of only 13 albatross species. The scientific logic adopted by Penhallurick & Wink (2004) was criticised by Rheindt & Austin (2005) who argued that later genetic studies (e.g. Burg & Croxall 2001; Abbott & Double 2003b; Burg & Croxall 2004) not considered by Penhallurick & Wink (2004) support the recognition of at least some of the 'new species' proposed by Robertson & Nunn (1998).

Taxonomic consensus is probably an unachievable goal. However, we believe that the current taxonomic confusion primarily exists due to a combination of three factors. First, as explained earlier, the identification of species boundaries among albatrosses and petrels is very difficult. Second, the rigour of the peer review process is variable and the process itself is fallible. Thus, unfortunately, less-than-robust taxonomic recommendations have been published in the scientific literature and been replicated in derivative secondary sources such as handbooks and field guides. Third, scientists, government departments and conservation bodies have adopted particular and often very different taxonomies without adequate justification.

This apparent lack of scientific rigour and taxonomic inconsistency was recognised at the latest International Albatross and Petrels Conference held in Montevideo, Uruguay in 2004. Delegates to this conference endorsed a submission encouraging ACAP to address these problems 'through the establishment of a transparent, scientifically defensible and highly consultative listing process. The process must promote taxonomic stability but allow revision when robust peer-reviewed studies suggest that amendment is necessary.' Acting on recommendations in this submission, Resolution 1.5 of the First Session of the Meeting of the Parties (MoP1) to ACAP provided for the establishment of a Working Group (WG) to review the taxonomy of all current species listed by the Agreement (Annex 1).

ATTACHMENT 5

**WORKING GROUP TO REVIEW THE TAXONOMY OF ALBATROSSES AND
PETRELS LISTED ON ANNEX I OF THE AGREEMENT**

WORK PROGRAM 2006-2007

Membership of Working Group

Party / Signatory/ Observer	Member	Organisation / position
Australia	Michael Double	Australian Antarctic Division
New Zealand	Geoff Chambers	University of Wellington
South Africa	Peter Ryan	University of Cape Town
United Kingdom	Mark Tasker	Joint Nature Conservation Committee
BirdLife International	Michael Brooke	BirdLife International

Timetable of progress

Action	Completed by	Responsibility
Review the evidence supporting the specific status of the following taxa: <ul style="list-style-type: none"> • Buller's and Pacific Albatrosses • Northern Royal Albatrosses and Southern Royal Albatrosses • Indian Yellow-nosed Albatrosses & Atlantic Yellow-nosed Albatrosses • Chatham Albatrosses & Salvin's Albatrosses • Northern Giant-petrels & Southern Giant-petrels • Black Petrels & Westland Petrels • White-chinned Petrels & Spectacled Petrels 	2006/2007	WG Convenor
To migrate the WG's web site to ACAP Secretariat	2006/2007	WG Convenor
Assess the utility of the subspecies rank for ACAP purposes and if appropriate develop guidelines for the recognition of subspecific status	2006/2007	WG Convenor
To construct a morphological and plumage database, then canvas for, collate, archive and summarise available data	2006/2007	WG Convenor
Maintain the WG's bibliographic database of published scientific papers relevant to the taxonomic status of ACAP listed taxa	2006/2007	WG Convenor
Develop and provide advice to AC on the construction and maintenance of species lists as appropriate	Ongoing	WG
Provide annual reports to AC on WG activities	2006/2007	WG Convenor
To draft resolutions (when necessary) for amendments to the species list in Annex 1 of the Agreement	Ongoing	AC

References

- Abbott, C. L. & Double, M. C. (2003a). Phylogeography of shy and white-capped albatrosses inferred from mitochondrial DNA sequences: implications for population history and taxonomy. *Molecular Ecology* 12:2747-2758.
- Abbott, C. L. & Double, M. C. (2003b). Genetic structure, conservation genetics, and evidence of speciation by range expansion in shy and white-capped albatrosses. *Molecular Ecology* 12:2953-2962.
- BirdLife International (2004a). 'Tracking Ocean Wanderers: the global distribution of albatrosses and petrels. Results from the Global Procellariiform Tracking Workshop, 1-5 September, 2003, Gordon's Bay, South Africa.' (Birdlife International: Cambridge UK).
- BirdLife International. 2004b. Threatened Birds of the World (CD ROM). BirdLife International, Cambridge.
- BirdLife International. 2007. Species factsheets: <http://www.birdlife.org>.
- Bourne, W. R. P. & Warham, J. (1966). Geographical variation in the giant petrels of the genus *Macronectes*. *Ardea* 54:45-67.
- Bourne, W. R. P. (2002). The classification of albatrosses. *Australasian Seabird Bulletin* 38:10-12.
- Brooke, M. (2004). 'Albatrosses and petrels across the world.' (Oxford University Press: Oxford).
- Brooke, R. K., Sinclair, J. C. & Berruti, A. (1980). Geographical variation in *Diomedea chlororhynchos*. *Durban Museum Novitates* 12:171-180.
- Burg, T. M. & Croxall, J. P. (2001). Global relationships amongst black-browed and grey-headed albatrosses: analysis of population structure using mitochondrial DNA and microsatellites. *Molecular Ecology* 10:2647-2660.
- Burg, T. M. & Croxall, J. P. (2004). Global population structure and taxonomy of the wandering albatross species complex. *Molecular Ecology* 13:2345-2355.
- Cracraft, J. (1983). Species concepts and speciation analysis. *Current Ornithology* 1:159-187.
- Croxall, J. P., Prince, P. A., Rothery, P. & Wood, A. G. (1998). Population changes in albatrosses at South Georgia. In: 'Albatross Biology and Conservation' (Ed. G. Robertson & R. Gales.) pp. 69-83. Surrey Beatty & Sons: Chipping Norton.
- Cuthbert, R., Ryan, P. G., Cooper, J. & Hilton, G. (2003a). Demography and population trends of the Atlantic yellow-nosed albatross. *Condor* 105:439-452.
- Cuthbert, R. J., Phillips, R. A. & Ryan, P. G. (2003b). Separating the Tristan albatross and the wandering albatross using morphometric measurements. *Waterbirds* 26:338-344.
- de Queiroz, K. (1998). The general lineage concept of species, species criteria, and the process of speciation. In: 'Endless forms: species and speciation' (Ed. de Queiroz, K. (1999). The general lineage concept of species and the defining properties of the species category. In: 'Species: New Interdisciplinary Essays' (Ed. R. A. Wilson.) pp. 49-89. MIT Press: Cambridge, Massachusetts.
- Double, M. C., Gales, R., Reid, T., Brothers, N. & Abbott, C. L. (2003). Morphometric comparison of Australian shy and New Zealand white-capped albatrosses. *Emu* 103:287-294.
- González-Solís, J., Croxall, J. P. & Wood, A. G. (2000). Foraging partitioning between giant petrels *Macronectes* spp. and its relationship with breeding population changes at Bird Island, South Georgia. *Marine Ecology-Progress Series* 204:279-288.

- González-Solís, J., Sanpera, C. & Ruiz, X. (2002). Metals and selenium as bioindicators of geographic and trophic segregation in giant petrels *Macronectes* spp. *Marine Ecology-Progress Series* 244:257-264.
- Hagen, Y. (1952). Birds of Tristan da Cunha. *Res. Norweg. Sci. Exped. Tristan da Cunha 1937-1938* 20:1-248.
- Harrison, P. (1979). Identification of Royal and Wandering Albatrosses. *Cormorant* 6:13-20.
- Harrison, P. (1985). 'Seabirds: An Identification Guide'. (Houghton Mifflin.
- Hedd, A., Gales, R. & Brothers, N. (2001). Foraging strategies of shy albatross *Thalassarche cauta* breeding at Albatross Island, Tasmania, Australia. *Marine Ecology Progress Series* 224:267-282.
- Helbig, A. J., Knox, A. K., Parkin, D. T., Sangster, G. & Collinson, M. (2002). Guidelines for assigning species rank. *Ibis* 144:518-525.
- Hockey, P. A. R., Dean, W. R. J. & Ryan, P. G., editors. (2005). Roberts' Birds of Southern Africa (VIIIth ed.). . Cape Town: The Trustees of the John Voelcker Bird Book Fund.
- Hunter, S. (1983). The food and feeding ecology of the giant petrels *Macronectes halli* and *M. giganteus* at South Georgia. *Journal of Zoology* 200:521-538.
- Isaac, N. J. B., Mallet, J. & Mace, G. M. (2004). Taxonomic inflation: its influence on macroecology and conservation. *Trends in Ecology & Evolution* 19:464-469.
- Marchant, S. & Higgins, P. J. (1990). 'Handbook of Australia, New Zealand and Antarctic birds.' (Oxford University Press: Melbourne).
- Mayden, R. L. (1997). A hierarchy of species concepts: the denouement in the saga of the species problem. In: 'Species: the Units of Biodiversity' (Ed. M. F. Claridge, H. A. Dawah & M. R. Wilson.) Chapman & Hall Ltd: London.
- Mayr, E. & Cottrell, G. W., editors. (1979). Peter's Checklist of the Birds of the World. Vol. 1 (2nd ed.). Cambridge, USA: Museum of Comparative Zoology.
- Medway, D. G. (1993). The identity of the Chocolate Albatross *Diomedea spadicea* of Gmelin, 1789 and of the Wandering Albatross *Diomedea exulans* of Linnaeus, 1758. *Notornis* 40:145-162.
- Murphy, R. C. (1917). A new albatross from the west coast of South America. *Bulletin of the American Museum of Natural History* 37:861-864.
- Nel, D. C., Taylor, F., Ryan, P. G. & Cooper, J. (2003). Population dynamics of the wandering albatross *Diomedea exulans* at Marion Island: Longline fishing and environmental influences. *African Journal of Marine Science* 25:503-517.
- Nunn, G. B., Cooper, J., Jouventin, P., Robertson, C. J. R. & Robertson, G. G. (1996). Evolutionary relationships among extant albatrosses (Procellariiformes: Diomedidae) established from complete cytochrome-b gene sequences. *Auk* 113:784-801.
- Nunn, G. B. & Stanley, S. E. (1998). Body size effects and rates of cytochrome b evolution in tube-nosed seabirds. *Molecular Biology & Evolution* 15:1360-1371.
- Onley, D. & Bartle, S. (1999). 'Identification of seabirds of the Southern Ocean: a guide for scientific observers aboard fishing vessels.' (Te Papa Press: Wellington, New Zealand).
- Onley, D. & Scofield, P. (2007). 'Albatrosses, Petrels and Shearwaters of the World.' (Christopher Helm: London).
- Penhallurick, J. & Wink, M. (2004). Analysis of the taxonomy and nomenclature of the Procellariiformes based on complete nucleotide sequences of the mitochondrial cytochrome b gene. *Emu* 104:125-147.

- Phillimore, A. B. & Owens, I. P. F. (2006). Are subspecies useful in evolutionary and conservation biology. *Proceedings of the Royal Society Biological Sciences Series B* 273:1049-1053.
- Reid, T. & Carter, M. J. (1988). The nominate race of the Yellow-nosed Albatross *Diomedea chlororhynchos chlororhynchos* in Australia. *Australian Bird Watcher* 12:160-164.
- Rheindt, F. E. & Austin, J. J. (2005). Major analytical and conceptual shortcomings in a recent taxonomic revision of the Procellariiformes - a reply to Penhallurick and Wink (2004). *Emu* 105:181-186.
- Robertson, C. J. & Nunn, G. B. (1998). Towards a new taxonomy for albatrosses. In: 'Albatross biology and conservation' (Ed. G. Robertson & R. Gales.) pp. 13-19. Surrey Beatty & Sons: Chipping Norton.
- Robertson, C. J. R. (1998). Factors influencing the breeding performance of the Northern Royal Albatross. In: 'Albatross Biology and Conservation' (Ed. G. Robertson & R. Gales.) pp. 20-45. Surrey Beatty & Sons: Chipping Norton.
- Robertson, C. J. R. (2002). The scientific name of the Indian yellow-nosed albatross *Thalassarche carteri*. *Marine Ornithology* 30:48-49.
- Robertson, G. & Gales, R. (1998). 'Albatross biology and conservation.' (Surrey Beatty: Chipping Norton).
- Roux, J. P. & Martinez, J. (1987). Rare, vagrant and introduced birds at Amsterdam and Saint Paul Islands, southern Indian Ocean. *Cormorant* 14:3-19.
- Rowan, A. N., Elliott, H. F. I. & Rowan, M. K. (1951). The "spectacled" form of the Shoemaker Procellaria aequinoctialis in the Tristan da Cunha group. *Ibis* 93:169-174.
- Ryan, P. G. (1998). The taxonomic and conservation status of the Spectacled Petrel *Procellaria conspicillata*. *Bird Conservation International* 8:223-235.
- Ryan, P. G. & Moloney, C. L. (2000). The status of Spectacled Petrels *Procellaria conspicillata* and other seabirds at Inaccessible Island. *Marine Ornithology* 28:93-100.
- Ryan, P. G., Dorse, C. & Hilton, G. M. (2006). The conservation status of the spectacled petrel *Procellaria conspicillata*. *Biological Conservation* 131:575-583.
- Shirihai, H. (2002). 'A complete guide to Antarctic wildlife.' (Alula Press: Degerby, Finland).
- Taylor, G. A. 2000. Action Plan for Seabird Conservation in New Zealand. Threatened Species Occasional Publication No. 16, Biodiversity Recovery Unit, Department of Conservation, Wellington, New Zealand.
- Techow, M. 2007. Phylogeny and phylogeography of four Southern Ocean petrels. PhD thesis Thesis. University of Cape Town, Cape Town, South Africa.
- van Bekkum, M. 2004. Microsatellite DNA analysis of breeding behaviour in Buller's albatross, *Thalassarche bulleri* Thesis. Victoria University of Wellington, Wellington, New Zealand.
- Voisin, J.-F. & Bester, M. N. 1981. The specific status of giant petrels *Macronectes* at Gough Island. African Seabird Group: Cape Town.
- Warham, J. (1990). 'The petrels - their ecology and breeding systems.' (Academic Press: London).
- Weimerskirch, H., Brothers, N. & Jouventin, P. (1997). Population dynamics of wandering albatross *Diomedea exulans* and Amsterdam albatross *D. amsterdamensis* in the Indian Ocean and their relationships with long-line fisheries - conservation implications. *Biological Conservation* 79:257-270.

- Weimerskirch, H., Guionnet, T., Martin, J., Shaffer, S. A. & Costa, D. P. (2000). Fast and fuel efficient? Optimal use of wind by flying albatrosses. *Proceedings of the Royal Society of London Series B-Biological Sciences* 267:1869-1874.
- Wiley, E. O. (1978). The evolutionary species concept reconsidered. *Systematic Zoology* 27:17-26.
- Xavier, J. C., Trathan, P. N., Croxall, J. P., Wood, A. G., Podesta, G. & Rodhouse, P. G. (2004). Foraging ecology and interactions with fisheries of wandering albatrosses (*Diomedea exulans*) breeding at South Georgia. *Fisheries Oceanography* 13:324-344.