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Suspended and delayed primary moult in breeding European Herring Gulls in the Dutch colony of IJmuiden Forteiland

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Abstract

Based on popular publications, it is widely believed in the gull research community (ourselves included) that adult European Herring Gulls *Larus argentatus argenteus* (hereafter Herring Gulls) replace their primaries as a continuous process, beginning in late April or early May.

While documenting the primary moult of colour-ringed adult Herring Gulls in the colony of IJmuiden Forteiland, the Netherlands, we did indeed observe this process, but also noticed that some individuals temporarily paused their primary moult, resuming it at the end of June or beginning of July, while others delayed the start of their primary moult until the beginning of July. When checking the literature, only a few references were found of adult Herring Gulls delaying their moult until July, and just two references describing cases where primary moult was suspended and later resumed. We therefore decided to investigate how often these delayed primary moult processes occur within the colony by monitoring multiple individuals across several breeding seasons.

Methods

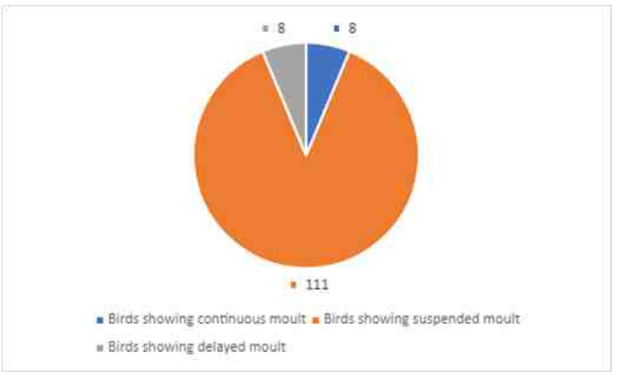
The research was performed in the gull colony of IJmuiden Forteiland, the Netherlands. It is located to the West of Amsterdam on an island in the entrance of the North Sea Canal (52°27'53.6"N 4°34'31.0"E). We have been studying gulls in this colony since 2008 by fitting individuals with a colour-ring on their leg.

The colour rings are dark green with a four-letter inscription starting with the letter Y, followed by a dot and three additional letters (Y.AAA). Each bird is given a unique code to allow for individual identification. In this article, birds are referred to by their code without the dot (YAAA).

During colony visits from mid-April to mid- or late July between 2014 and 2020, individual gulls were photographed using a digital DSLR camera. We used the moult scoring method as described by Ginn & Melville (1983). Primaries are numbered from the inside (primary 1, P1) to the outside (primary 10, P10) and scored as 0 (old feather), 1 (old feather missing or new feather growing in), 2 (new feather just emerging from the sheath or up to one-third in size), 3 (new feather between one and two-thirds in size), 4 (new feather between two-thirds and just under full size), or 5 (new feather at full size). The moult status of a wing can then at any time be described as a sequence of 10 digits, representing scores of each primary. For example: '100000000' indicates a wing in which P1 has been dropped and P2-P10 are old and still present. For this project, however, the specific score was less relevant; the primary focus was to see if primaries were (almost) fully grown while the next primary was still in place.

Moult type	Total	Female	%	Male	%2
Continuous moult	8	3	38%	5	62%
Suspended moult	111	46	41%	65	59%
Delayed moult	8	4	50%	4	50%
Moult type	**Total**	**Female**	**% Ratio females**	**Male**	**% Ratio males**
Continuous moult	8	3	6%	5	7%
Suspended moult	111	46	87%	65	88%
Delayed moult	8	4	7%	4	5%
Total	127	53	100%	74	100%

Table 1: Moult type per sex.



Graph 1: Total birds per moult strategy type.

For birds with all 10 primaries still present, the colour and state of primary feathers could also be used to determine if they were new or old: new primaries are a colder blue/grey and fresh looking with no signs of wear, and show a contrast to the adjacent, old feather.

For each observation, the primary moult was classified as follows:

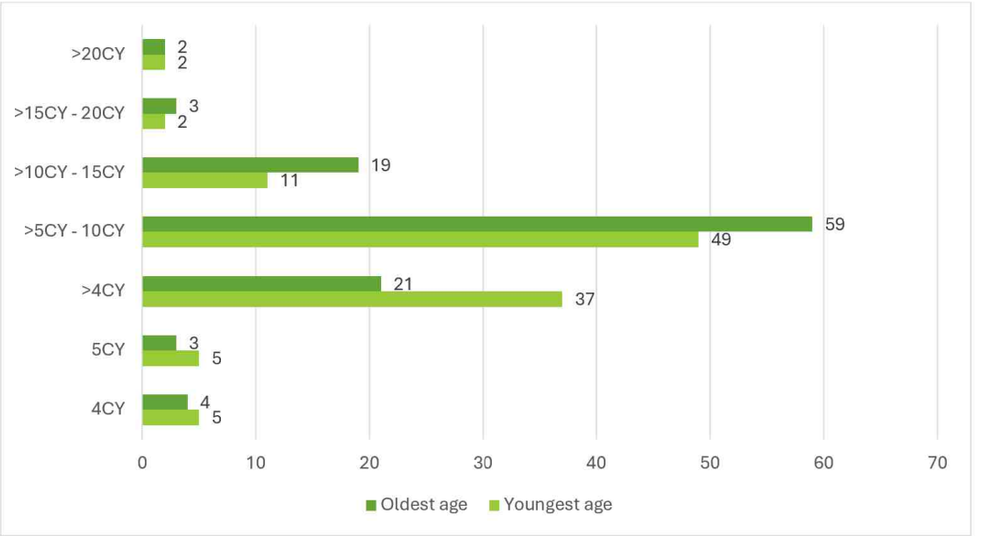
- 'Continuous' when primaries were continuously replaced starting in April/May, or a high moult score (higher than 10) was recorded after June 1.
- 'Suspended' when in June or July, one or more of the inner primaries (P1, P1 & P2, or P1, P2 & P3) were (almost) fully grown (score 4 or 5) with the next primary (P2, P3, or P4) still present or missing (score 0 or 1).
- 'Resumed' when active primary moult had been noted after suspension.
- 'Delayed' when P1 is still present (score 0) or missing (score 1) in July.
- 'Unknown' when the primary score could not be sufficiently interpreted.

For each bird, a 'moulting strategy' was determined for each season using the following classifications:

- Continuous. For birds which started their moult in April to early May and replaced their primaries one by one in a continuous process: as soon as one primary was nearly fully grown, the next primary was dropped.
- Suspended. For birds of which P1, P1 & P2, or P1, P2 & P3 was replaced in April/May, the moult was paused when these primaries were fully grown while the next primary was still present, and the moult was continued shortly thereafter.
- Delayed. For birds which delayed the start of their primary moult until July (P1 present (score 0) or missing (score 1) in July).
- Unknown. For birds with insufficient data to verify suspended primary moult.
- No data. For birds for which there was no recorded data (either the bird was not seen that year, had not yet been ringed, or was no longer alive).

Results

Out of 190 birds with available primary moult data,



Graph 2: The studied birds by age. Because birds were recorded over multiple seasons (table 1), birds are divided by oldest recorded age and youngest recorded age.

Graph 3: Moult strategies for pairs in the same season.

continuous primary moult was recorded in 8 birds (4%), suspended primary moult in 111 birds (58%), and delayed moult in 8 birds (4%). Note that some birds had different moult strategies in different seasons and are therefore recorded more than once (see Appendix tables A1, A2, and A3).

We observed 50 females and 69 males showing continuous or suspended primary moult, and 3 females and 5 males showing continuous moult. When looking at the ratio of each moult type within the group of females and males though, the ratio for each moult type between females and males are very similar (table 1).

Suspended or delayed primary moult was also observed in individual birds over consecutive seasons (table Appendix A4). Suspended primary moult was observed for 24 birds across 2 consecutive seasons, for 5 birds across 3 consecutive seasons, for 1 bird across 4 consecutive seasons, for 3 birds across 5 consecutive seasons, and for 1 bird (YBRB) across 6 consecutive seasons. Delayed primary moult was observed for no more than 2 consecutive seasons in 3 birds.

A variation in moult strategy was recorded for 11 birds: 8 birds showed continuous moult in one season and suspended moult in another, while for 3 birds suspended moult was recorded in one season and delayed moult in another season (table Appendix A5).

Suspended primary moult was recorded for birds in all age ranges: from birds as young as in their 4th calendar year to birds as old as 20 calendar years or older (graph 2). The oldest recorded bird was in its 25th calendar year (YAUC in 2018).
Data from 22 pairs allowed us to compare the primary moult strategies of both partners within the same season (graph 3). In 20 pairs, both partners had suspended primary moult simultaneously in one or more seasons, including 5 pairs in 2 seasons and 2 pairs in 3 seasons. In 2 pairs, one partner showed suspended primary moult while the other had continuous primary moult: one pair in 1 season, and one pair in 2 seasons. In 3 pairs, one partner showed suspended moult while the other partner had delayed moult: one pair in one season and 2 pairs in 2 seasons.

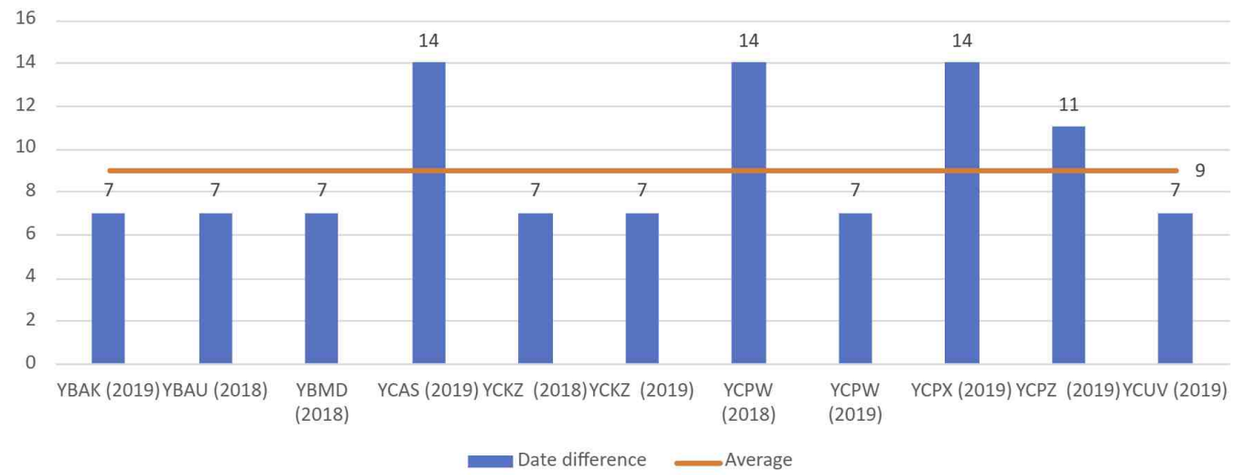
For the birds showing suspended primary moult, the peak period in which it was observed that P1 was dropped, was in the third week of May. The earliest recorded drop was in the fourth week of April, and the latest recording in the third week of June.
In 27 seasons (for a total of 22 birds), primary moult was observed to have been resumed after being suspended. In 11 of these seasons, an accurate calculation could be made about the number of days between the suspension and observation of resumption (table 2 and graph 4). This period ranged from 7 to 14 days with an average of 9 days. Note that for accurate calculations, daily checks of the birds would be necessary, while we only visited the colony up to twice a week.

Discussion

According to the literature, adult Herring Gulls replace their primary feathers once every 12 months (Walters 1978; Cramp & Simmons 1983; Olsen 2004), starting with inner primary 1 (P1) in late April-May (Barth 1975, Coulson *et al* 1983, Cramp & Simmons 1983, Olsen 2004, Muusse *et al* 2011, Verbeek 1977, Walters 1978), and finishing with the outer primaries P9 and P10, in late October-early November (Walters 1978, Barth 1975; Coulson *et al* 1983, Cramp & Simmons 1983, Olsen 2004, Muusse *et al* 2011, Verbeek 1977) or December (Coulson *et a*l 1983).

Bird	Sex	Season	Suspended moult start	Suspended moult resumed	Day difference
G-YBAK	M	2019	5 Jul 2019	12 Jul 2019	7
G-YBAU	F	2018	16 Jul 2018	23 Jul 2018	7
G-YBHN	M	2016	Unknown	Unknown	Unknown
G-YBMD	M	2018	25 Jun 2018	2 Jul 2018	7
G-YBMD	M	2019	Unknown	Unknown	Unknown
G-YBPR	F	2019	Unknown	Unknown	Unknown
G-YBUH	F	2019	Unknown	Unknown	Unknown
G-YBUW	F	2019	Unknown	Unknown	Unknown
G-YBXB	M	2018	Unknown	Unknown	Unknown
G-YCAH	F	2019	Unknown	Unknown	Unknown
G-YCAS	M	2019	17 Jun 2019	1 Jul 2019	14
G-YCBC	M	2019	Unknown	Unknown	Unknown
G-YCBV	F	2019	Unknown	Unknown	Unknown
G-YCHN	M	2019	Unknown	Unknown	Unknown
G-YCKZ	M	2018	16 Jul 2018	23 Jul 2018	7
G-YCKZ	M	2019	15 Jul 2019	22 Jul 2019	7
G-YCPW	M	2018	25 Jun 2018	9 Jul 2018	14
G-YCPW	M	2019	24 Jun 2019	1 Jul 2019	7
G-YCPX	F	2019	1 Jul 2019	15 Jul 2019	14
G-YCPZ	F	2019	3 Jun 2019	14 Jun 2019	11
G-YCPZ	F	2020	Unknown	Unknown	Unknown
G-YCUT	F	2019	Unknown	Unknown	Unknown
G-YCUV	M	2019	5 Jul 2019	12 Jul 2019	7
G-YCUZ	M	2020	Unknown	Unknown	Unknown
G-YCVJ	M	2019	Unknown	Unknown	Unknown
G-YBPT/ G-YDAR	M	2017	Unknown	Unknown	Unknown
G-YBPT/ G-YDAR	M	2018	Unknown	Unknown	Unknown

Table 2: Dates and differences between the start of suspended primary moult and when it was resumed.



Graph 4: The number of days after which suspended moult was seen as resumed.

For almost all Herring Gulls this is a continuous process, where P1 (or P1 and P2) are dropped first. When P1 or P1 and P2 are almost fully grown, the next single primary is shed. When that primary is almost fully grown, the next primary is dropped, and so on until all 10 primaries are replaced.

Some Dutch and British adult Herring Gulls can start their moult as late as mid-July (Walters 1978, Cramp & Simmons 1983). Harris (1971) states that Herring Gulls in the United Kingdom start their moult in late June or early July, while Barth (1975) refers to 10 Herring Gulls from Walney Island, Lancashire, UK, who initiated their primary moult at the beginning of June. Our data confirm this strategy of delayed primary moult. However, we also found that adult Herring Gulls can follow a third moulting strategy, where the primary moult is commenced in mid-May, suspended in June or July, and shortly thereafter resumed. During the suspension period, a full set of 10 primaries is present. Verbeek (1977) refers to 30 Herring Gulls in the UK in which all primaries were old except the first and the second, indicating suspended primary moult, though he does not state when this was observed. He also states that by the end of June, all Herring Gulls had begun their primary moult, which means that no delayed primary moult was observed.

Only two articles were found in the literature (Lindholm & Forsten, 2005, in Swedish, Ahmed *et al* 2010) that mention primary moult in adult Herring Gulls slowing down and then often stopping completely at the end of June or beginning of July, with full moult activity resuming by the end of July. They are accompanied by a photo of a Herring Gull in Finland showing suspended primary moult in July. The data from these articles is based on single observations of gulls (some colour-ringed, some not ringed) in the field, such as landfills, during a single season. We were fortunate enough to base our study on a large group of gulls which could be individually recognized and followed over multiple seasons. As a result, we believe that we can now shed more light on these different primary moult strategies.

In our study, more than half of the observed gulls (111 birds, 58%) showed suspended primary moult, while only 8 birds (4%) exhibited continuous primary moult. An additional 8 birds (4%) showed delayed primary moult. (Note again that some birds had a different moult strategy in different seasons and are therefore recorded more than once.) This significantly contradicts the widely held belief that adult Herring Gulls start their primary moult in April to early May and undergo a continuous primary moult process. We believe that the lack of knowledge in literature is caused by the many factors required to accurately document this phenomenon. It necessitates a group of individually recognizable gulls that can be regularly followed during the breeding season (preferably also over multiple consecutive years), and photographed often while they are in flight. In our project at the IJmuiden Forteiland colony, this was possible thanks to the about 90 Herring Gull pairs (the majority colour-ringed) that return annually to a compact colony, offering clear views to document them. The availability of digital photography also greatly enhanced our ability to capture these observations,

Photo1a: YCHH on 17 June 2019 showing suspended primary moult: P1 and P2 have been replaced while all other primaries are still present. IJmuiden Forteiland, The Netherlands. © Maarten van Kleinwee.

Photo 1b: YCHH on 10 November 2019 showing an almost fully grown P10. Scheveningen, The Netherlands. © Maarten van Kleinwee.

compared to the analogue age of the 1970s and 1980s during which primary moult in Herring Gulls was also researched.

Although primary moult is nowadays often recorded as part of research projects across Europe, this is typically done when breeding birds are caught for ringing. For European Herring Gulls, this takes place at the end of April and the beginning of May, when the nest contains a full clutch of 2-3 eggs. This timing is too early to record suspended primary moult. In some projects, adult Herring Gulls are also caught in May and early June (Muusse *et al* 2011, Camphuysen 2013) which would make it possible to observe the first instances of suspended primary moult, but no documented cases of ringed birds are known. To determine if a bird is following a continuous, suspended, or delayed primary moult strategy, it must be monitored regularly throughout the season, preferably from April until July.

It is also unclear if all instances of delayed moult in the literature are truly delayed moult. Birds observed from a distance with all 10 primaries intact, can, in fact, have already replaced their inner primaries. The slight differences in colour and lack of wear on these new feathers make them hard to distinguish from older ones. It might well be that birds observed or photographed with a full set of primaries at the beginning of July had already replaced P1 and/or P2. Because the subtle differences can be hard to detect when they are not expected to be present, such birds might well have been mistakenly scored as exhibiting delayed primary moult instead of suspended primary moult.

Bird feathers wear over time because of abrasion, sunlight, and parasites, and need to be replaced to maintain sufficient insulation and flight efficiency (Jenni and Winkler 2020). In gulls, the primary feathers are replaced once every 12 months (Harris 1971, Walters 1978, Cramp & Simmons 1983, Olsen 2004) in a process that takes some 6 months to complete (Walters 1978, Cramp & Simmons 1983, Ginn & Melville 1983; Olsen 2004). However, Harris (1971) reports an average period of only four months for populations on Skokholm and Skomer islands in Pembrokeshire, UK. Verbeek (1977) agrees that while some individuals may complete moult in this shorter time, the process generally takes six months at the population level.

The processes of breeding and replacing primaries takes up a gull's time, energy, and flight performance and are therefore in conflict with each other (Jenni & Winkler 2020). Dutch Herring Gulls need to schedule these energy consuming processes together with other crucial periods during their annual cycle: the twice-yearly moulting of feathers on the head and parts of the body (pre- and post-breeding), egg-laying and rearing of young during the breeding season (April to August), the moulting of the secondary wing and tail feathers (which occurs simultaneously while moulting the outer primaries), and enduring the winter season in the cold climate of the Netherlands, Belgium, and northern France (Camphuysen 2013). The primary moult in European Herring Gulls is completed by late October-early November (Walters 1978, Cramp & Simmons 1983) coinciding with the onset of winter. A secondary benefit of completing the primary moult by November would be to signal a good health state when bonding with a partner in December to February by showing a complete and fresh plumage.

To complete the primary moult by November in a schedule of 6 months, it must start in April or May. This is indeed the period that is supported by literature for adult European Herring Gulls. As our results show, adult Herring Gulls may start the moult in April, May or later, and can follow one of three primary moult strategies: continuous, suspended, or delayed.

The reasons for selecting one strategy over another are unclear. It would be logical to link this choice to the laying of eggs and the raising of chicks. However, these factors are consistent for all breeding birds, and they do not fully explain what triggers a particular strategy. Moreover, as shown in Graph 3, partners of the same nest can follow different strategies in the same season, while the breeding conditions are obviously identical.

For birds showing suspended or delayed primary moult, we observed that P1 was dropped during the incubation period, while the primary moult was suspended or delayed during the care of chicks and/or large young. However, the primary moult resumed quickly: between 7 and 14 days. Once the primary moult was resumed, chicks were growing fast into juveniles which require more and more food.

Suspended and resumed primary moult was also recorded in two birds that had lost their eggs and for five birds who had lost their chicks. This raises the question: is suspended primary moult and its

resumption predetermined at the beginning of the season, regardless of breeding success? Table A5 shows that individuals can follow different strategies across seasons. What triggers the choice of strategy for a given season and when does this decision take place? Is the strategy of a bird influenced by the strategy of its partner, and how would this be detected?

If primary moult resumes just a few days after being paused, during a period of high-energy consuming activities such as feeding chicks, wouldn't it be more accurate to describe this as slow-paced primary moult rather than suspended moult? Further and more detailed research is required to answer these questions.

No research was done on the completion of the primary moult for the 111 birds that were found to have suspended or delayed their primary moult. However, YCHL was observed in November 2019 with P10 almost fully grown. On June 17 of that year, P1 and P2 where fully grown, while P3 was still present (suspended moult), By July 1, P3 was missing (resumed moult), and by July 15, it was half-grown (figure 1a and 1b). The fact that P10 was almost fully grown in November indicates that the primary moult can advance quickly for these individuals, allowing them to complete moult by November, simultaneously with individuals that follow a continuous moult strategy. However, it is possible that these fast-grown feathers are of lower quality compared to feathers grown in the continuous moult (Jenni and Winkler 2020).

Summary

We discovered that adult breeding Herring Gulls can temporarily suspend their primary moult and that not much is known about this process. More than half (58%) of the followed birds showed suspended primary moult in at least one season, with 39% of these birds suspending their primary moult in more than two seasons, and one individual doing so in all six observed seasons. This shows that suspended primary moult was very common among the birds that we followed. While literature frequently mentions cases where adult Herring Gulls delay the moult of P1 until July, we found only a few such instances in our project (8 birds, 4%). We found that suspended primary moult in adult Herring Gulls does not seem to be related to the sex or age of the bird. Suspended primary moult is observed exclusively in breeding Herring Gulls. The absence of reports of suspended primary moult in the first or second primary moults further suggests that this phenomenon is linked to breeding. We found that suspended primary moult can occur in multiple seasons for a bird, though not necessarily in consecutive seasons. (Note that the actual number of birds with multiple seasons of suspended moult may be higher, because moulting data for all seasons was not always available for every bird.) Pairs typically both follow the suspended primary moult strategy, while a mixed strategy was found only in a few cases. We did not investigate the reasons for why adult Herring Gulls suspend their moult, but possible explanations are given in the discussion.

We encourage further research into the various primary moult strategies used, and the reasons behind continuous, suspended, and delayed primary moult in adult breeding Herring Gulls, as well as in related species such as Scandinavian *Larus argentatus argentatus* and American Herring Gulls *L. smithsonianus*, Caspian Gulls *L.cachinnans*, and Yellow-legged Gulls *L. michahellis*.

Acknowledgements

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Photo 2a: Photos 2a-2d illustrate male YBMD at IJmuiden Forteiland, The Netherlands. Photos show the process of suspending and resuming the primary moult in 2018. YBMD had 2 two chicks on June 18. Suspended primary moult was observed on June 25. No chicks were seen on June 25 or after. Resumed primary moult was observed on July 2. This photo was taken on May 7, when no primaries were moulted yet. © Maarten van Kleinwee.

Photo 2b: June 11, active primary moult: P1 growing, P2 missing/growing, other primaries present. © Maarten van Kleinwee.

Photo 2c: June 25: suspended primary moult: P1 and P2 replaced, all primaries present. © Maarten van Kleinwee.

Photo 2d: July 9, resumed primary moult: P3 and P4 missing/growing. © Maarten van Kleinwee.

Photo 3a: Female YBRB with suspended primary moult, 4 July 2016. P1 and P2 fully grown, P3 to P10 still present. Note the difference in colour between the new primaries P1 and P2 and the old primaries P3 to P10. IJmuiden Forteiland, The Netherlands. © Maarten van Kleinwee.

Photo 4a: Male YBRD showing active and suspended primary moult in 2015. On 26 May primary moult has started with P1 and P2 missing. IJmuiden Forteiland, The Netherlands. © Maarten van Kleinwee.

Photo 4b: Male YBRD on 29 June. P1 and P2 are fully grown with all other primaries present. IJmuiden Forteiland, The Netherlands. © Maarten van Kleinwee.

Photo 5a: Male YCHL showing delayed primary moult in 2018. On 16 July (top) all primaries are still present. IJmuiden Forteiland, The Netherlands. © Maarten van Kleinwee.

Photo 5b: Male YCHL showing delayed primary moult in 2018: on 23 July P1 and P2 are dropped. IJmuiden Forteiland, The Netherlands. © Maarten van Kleinwee.