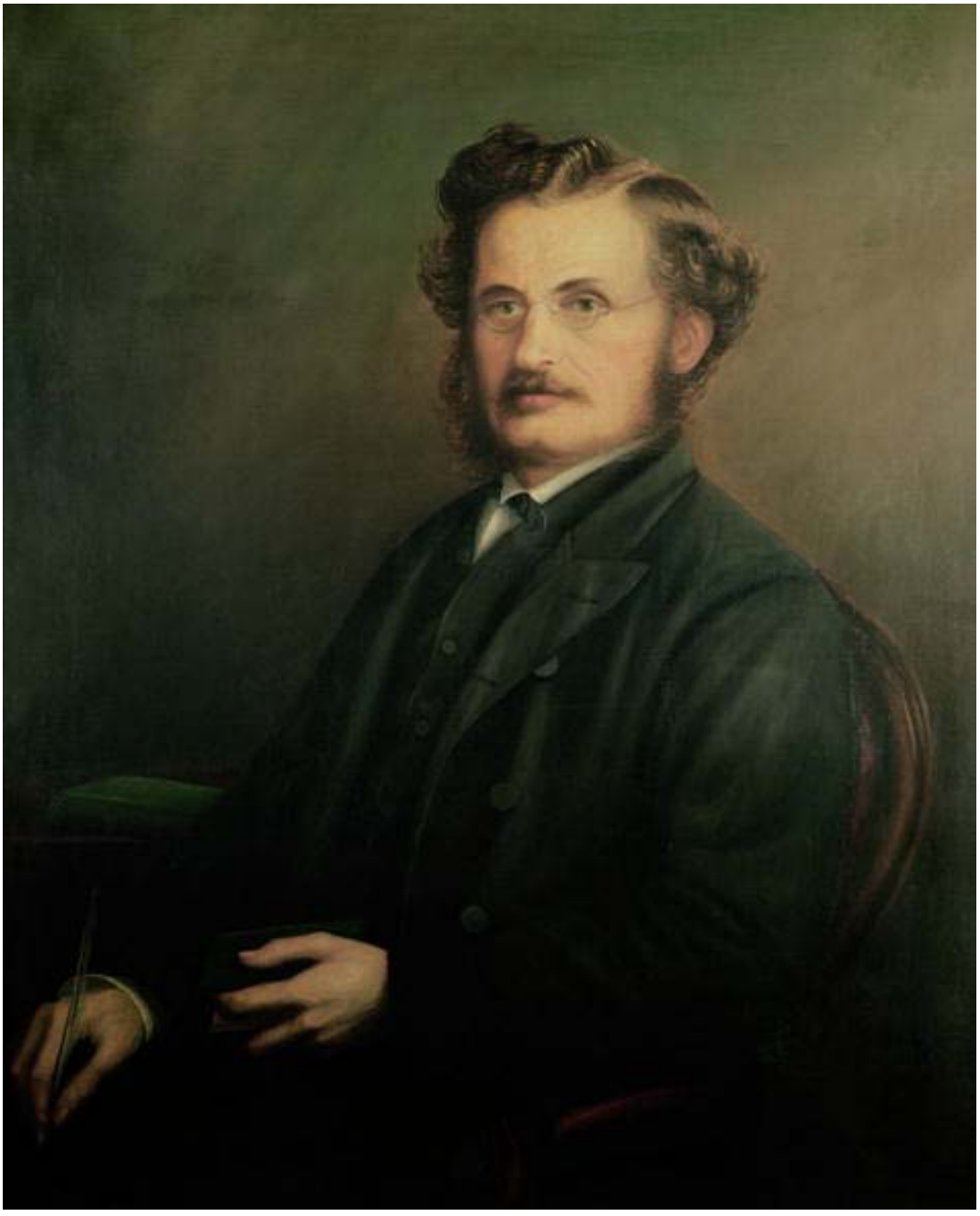
Natural Mimics

Later on today you'll be writing a letter home from the Amazon rainforest, as you imagine what it would have been like to be Victorian explorer and naturalist Henry Walter Bates. Bates travelled throughout South America in the mid-nineteenth century, discovering new species and biological phenomena (such as 'Batesian mimicry') that arguably supported evolutionary theory. The first part of his journey was spent with Alfred Russel Wallace who – alongside Charles Darwin – was the co-discoverer of the principle of natural selection, the keystone of evolution.

This morning you'll be reading through these documents to get a sense of who Bates was, what he was doing, and how this community of people studying nature wrote to each other about their work. In this pack, then, you will find further details of Bates' life; examples from Bates' letters and notebooks; pictures of him in the Amazon; images of contemporary specimens, and illustrations of Batesian mimicry. We have focused on two particular examples: hummingbirds and butterflies – pick which one you would like to discuss with your imagined correspondent.

Use this historical evidence to imagine what it would have been like encountering these creatures and landscapes. How would you analyse what you're looking at? How would you fit it together with what you already know? How would you report on your findings to friends and colleagues back home? How would you propose new ways of looking at nature, based on your findings?

Henry Walter Bates, 1825-1892



Dictionary of National Biography (edited) – Henry Walter Bates

Bates, Henry Walter (1825–1892), naturalist, was born at Leicester on 8 February 1825, the eldest of the four sons of Henry (1794–1870), a hosiery manufacturer, and Sarah, *née* Gill (1803–1860). He was educated at Creaton's academy at Billesdon, a village 10 miles east of Leicester. He left school in 1838, but continued his education at evening classes at the Leicester Mechanics' Institute, while apprentice to another Leicester hosier, Alderman Gregory. On Gregory's death he briefly managed the business before becoming a clerk at Allsopp's brewery in Burton upon Trent. A number of his fellow students were interested in nature and he became a self-taught naturalist, spending his free time in the careful observation and collection of insect life in the Leicestershire countryside and later around Burton upon Trent. He published his first paper in 1843, in the first number of *The Zoologist*, which subsequently carried several of his early articles on local entomology.

In 1844 Bates met Alfred Russel Wallace, then a master at Leicester collegiate school. They collected insects together and found a common interest in the writings of Alexander von Humboldt and Charles Lyell, and in the anonymous *Vestiges of the Natural History of Creation*, which had been a publishing sensation in 1844. After Wallace returned to south Wales in 1846 they corresponded, and at Wallace's suggestion decided upon an expedition to the Amazon, to study the region's wildlife—collecting duplicate specimens for sale to defray their expenses—in the hope of contributing ideas to the debate about the origin of species. After rapid preparations at the British Museum and Kew Gardens, they sailed from Liverpool in the trading vessel *Mischief* on 26 April 1848, and arrived in Belém (then known as Pará) on 28 May. Their initial base was Belém, from where they collected locally, on the island of Marajó, and on expeditions up the River Tocantins in 1848 and 1849; they separated in 1849.

Wallace returned to England in 1852, but Bates was to remain in Amazonia for eleven years, collecting around bases at Belém, Ega (1850–51 and 1855–9), and Santarém and Villa Nova (1851–5); along the Amazon; and on expeditions up the Tapajos (1852) and as far west as São Paulo on the Solimões in 1857. He worked alone, using local river craft, and, after their introduction in 1853, steamboats. Although his main interest was in insects, particularly butterflies and beetles, he also collected animals, birds, reptiles, plants, shells, and Indian artefacts. These were sold by his London agent, Samuel Stevens, to museums and private collectors, but he also sought specific items for public and private collections. In total he dispatched some 14,700 species back to England, 8000 of them new to science.

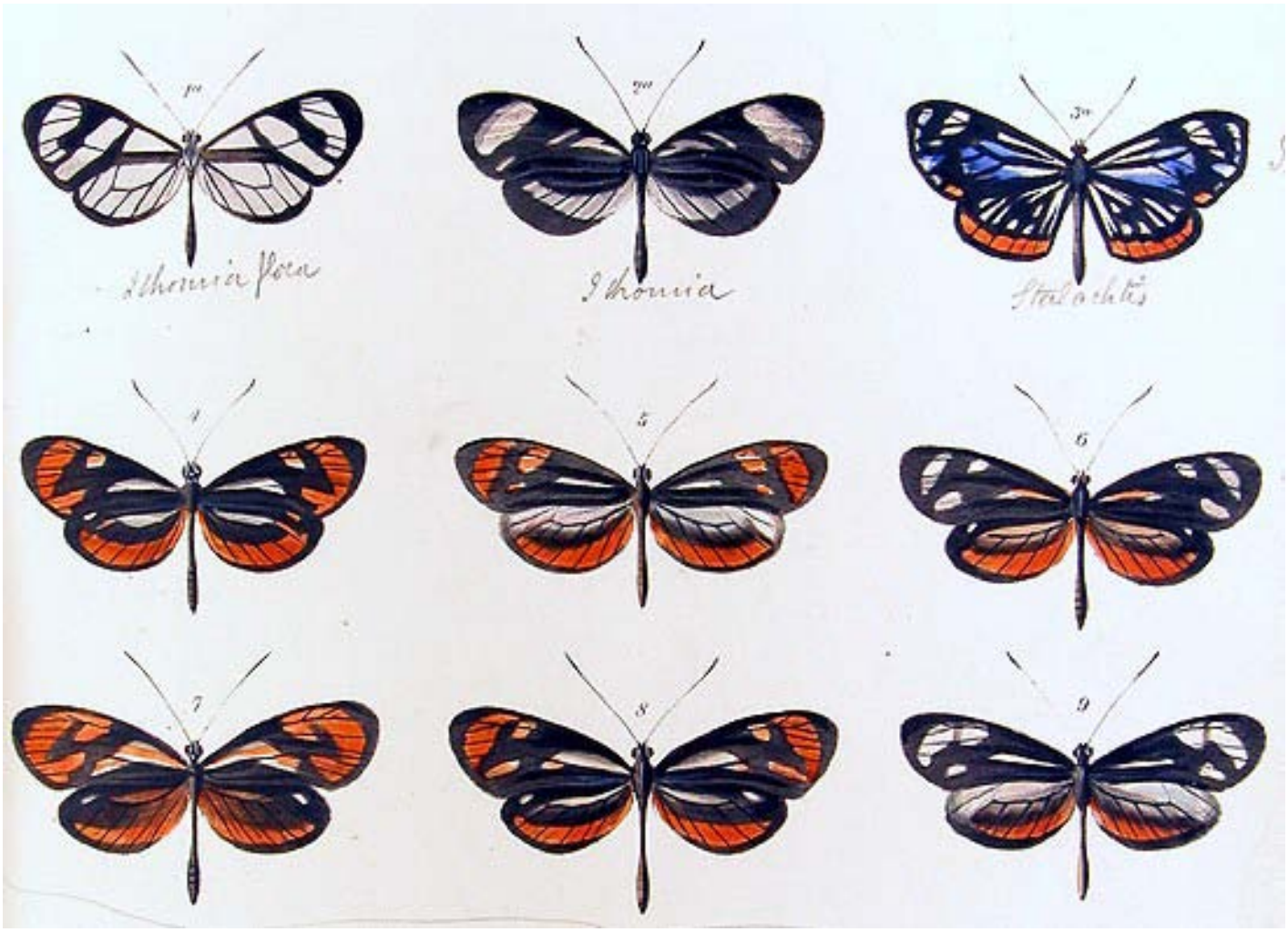
During 1858 Bates's health deteriorated and he left the upper Amazon in February 1859 and spent two months in Belém before embarking for England on 2 June 1859. He settled in Leicester, describing himself in 1863 as a worsted hosier. However, he had begun to write up the collections he had made, and produced a series of major papers, published in the *Transactions of the Linnean and Entomological societies*, and the *Annals and Magazine of Natural History* between 1859 and 1862. The most significant was the 'Contributions to an insect fauna of the Amazon valley: Lepidoptera

Heliconidae' (Transactions of the Linnean Society, 1862) which described resemblances between two families of butterflies, of which the similarity of one to the other served as protection against predators. Such protection, or mimicry, could be an aid to survival and thus to natural selection, and has come to be known as Batesian mimicry. The phenomenon offered supporting evidence to the arguments on natural selection expounded by Charles Darwin in *The Origin of Species* (1859). In a letter to Bates in November 1862, Darwin described the paper as one of the most 'remarkable and admirable' he had ever read, and Bates became an advocate of Darwinian ideas, making early reference to them at meetings of the Entomological and Linnean societies. In 1860 the two men had begun a correspondence which lasted until Darwin's death in 1882. Darwin frequently asked Bates for information on the insects and other wildlife of Amazonia, and it was at his suggestion that Bates wrote an account of his travel experiences, Darwin recommending Bates to his own publisher, John Murray.

The Naturalist on the River Amazons (2 vols., 1863) was a major contribution to the knowledge and literature of Amazonia. Bates had spent longer on the Amazon than any of his European predecessors, and the book was an immediate success and has become a travel classic. It remained in print through the nineteenth century, in eight editions, and was also published in Russian, German, and Swedish in 1865, 1866, and 1872 respectively. It is a curiously structured book, part detailed diary, part general account of the region, and part precise description of particular fauna, but it provides a fascinating record of the natural environment and wildlife of Amazonia before the major impact of the rubber boom. There are also detailed descriptions of the way of life and customs of Amerindian groups Bates encountered on his travels. The book's enduring appeal lies in its elegant yet scientific pen-portraits of places, people, and wildlife, as in his description of the wings of the varied and beautiful butterflies he observed around Ega: 'on these expanded membranes nature writes, as on a tablet, the story of the modification of species, so truly do all changes of the organisation register themselves thereon' (Bates, 353).

...
Bates was described as a good-looking man of rugged appearance, with a large head and a high, deeply furrowed forehead. He suffered from gastric trouble as a youth, and there are suggestions in several newspaper obituaries that he returned from Amazonia broken in health. His diet there was certainly meagre, and he caught yellow fever in 1851, and an attack of 'ague' (malaria) while at São Paulo in 1857 was responsible for the decline in health which prompted his decision to leave Brazil. In England, however, he lived for a further three decades, dying of influenza complicated by bronchitis at 11 Carleton Road, Tufnell Park, London, on 16 February 1892. He was buried in Marylebone cemetery in north London. The obelisk marking his grave (where his wife, Sarah, is also buried), is topped by a globe which has South America to the fore, and records him as 'Author of the *Naturalist on the River Amazons*'...

John Dickenson (copyright Oxford University Press)



Batesian Mimicry

"a form of biological resemblance in which a noxious, or dangerous, organism (the model), equipped with a warning system such as conspicuous coloration, is mimicked by a harmless organism (the mimic). The mimic gains protection because predators mistake it for the model and leave it alone. This form of mimicry is named for its discoverer, the 19th-century English naturalist H.W. Bates."

Encyclopaedia Britannica online

Letters from Alfred Russell Wallace to Bates (edited)

Neath, Glamorgan, Oct. 3rd. 1845.

Dear Sir,

You perhaps think that I have quite forgotten any promise of writing to you, but the fact is that I have been for the last **3 months** so very busy that I have really not had time, or even when I could get a little leisure the low state of my Entomological finances prevented me - all the finest weather of the latter part of the summer has been spent by me in a manner which you might consider very favourable to Entomolical [sic] pursuits - viz. in surveying & levelling among the most romantic parts of this beautiful & highly interesting district - But it is really astonishing the few insects which come unsought upon ones view: and though I keep a constant look out at all times when any attention is not otherwise engaged yet but scanty are my gleanings.

One day whilst traversing a most romantic rocky glen surrounded by the most magnificent precipices I discovered a fine larva of the Elephant Hawk moth (*Deilephila Elpenor*) which I have now just about to change into a pupa and this is about all worth mentioning

For the past few weeks after leaving Leicester I had a little leisure & took several nice Coleoptera - a list of such as I have duplicates of I send & trust there maybe some which will be acceptable to you - The great abundance of "Phylloperthahorticola" & "Itoplia argentea" is one feature of this neighbourhood, the former I could have taken by thousands everywhere.

"Melasonia populi" I took in great quantities or the dwarf "Lasiocampa rubi" is now very abundant here feeding both on the bramble but also very plentifully found on mountains feeding on the Common heath. (*Calluna vulgaris*) - I am afraid they live through the winter as I see no symptom of those I have giving up eating

The following is a list of any duplicates - …

I hoped to have had some nice butterflies to send you but I have been out of the way of them on all the fine days - The Grayling butterfly (Hipparchia semele)is abundant here but I have not yet had an opportunity of getting good specimens - Have you it at Leicester?

I got the Shuckard's Coleoptera delineated, at Bohn's - they have bought the work & sell it for 180.- at which price it is well worth having as it is a most beautiful & useful work - remember me to your friend Mr Kirby. Hoping you will write me a letter full of Entomological news I remain

Yours sincerely, Alfred R. Wallace

Neath, Dec[embe]r 28th. 1845.

My Dear Sir
I do not think I sh[oul]d. like the boxes unglazed so well as a comparatively cheaply made Cabinet with glass which I therefore think I shall get made.

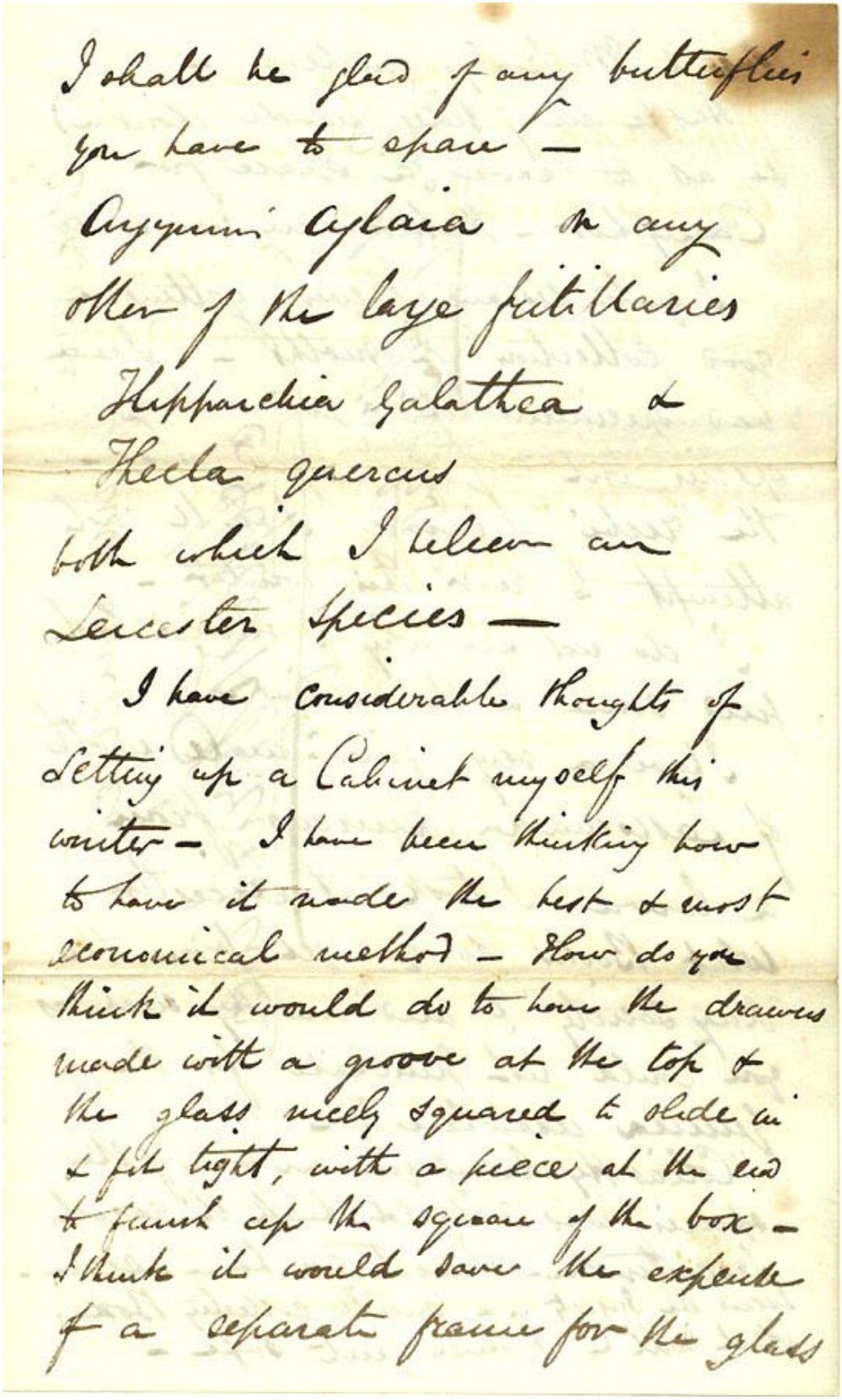
I have rather a more favourable opinion of the "Vestiges" than you appear to have. I do not consider it as a hasty generalisation, but rather as an ingenious hypothesis strongly supported by some striking facts and analogies but which remains to be proved by more facts & the additional light which future researchers may throw upon the subject - it at all events furnishes a subject for every observer of nature to turn his attention to; every fact he observes must make either for or against it, and it thus furnishes both an incitement to the collection of facts & an object to which to apply them when collected – I would observe that many eminent writers gave great support to the theory of the progressive development of species in Animals & plants …

now I sh[oul]d say that a permanent peculiarity not produced in any way by external causes is a distinction of species & not of mere variety … An animal which differs from another by some decided & permanent character however slight which differences is undiminished by propagation& unchanged by climate & external circumstances, …is invariably considered as a distinct species - while one which is not propagated so as to form as distinct race, but is produced more frequently from the parent stock … is generally if the difference is not very striking, considered a variety, - now I consider both these to be equally, distinct species, & I would only consider those to be varieties whose differences are produced by external causes & which therefore are not propagated as a distinct race.

In how many cases in the animal world & particularly among Insects are the differences between species far less than those between varieties, so consid[ere]d neither however being produced by external circumstances. How well too does this theory account for those excessively rare species whose Existence seems almost a mystery. They may be produced by more Common species at intervals in the same manner as the Albino is from European Parents. As a further support to the "Vestiges" I have heard that "Cosmos" the celebrated work by the venerable Humboldt supports in almost every particular its theories not excepting those relating to Animal & vegetable life - This work I have a great desire to read but fear I shall not have an opportunity at present - Read Lawrence's work – it is well worth it.

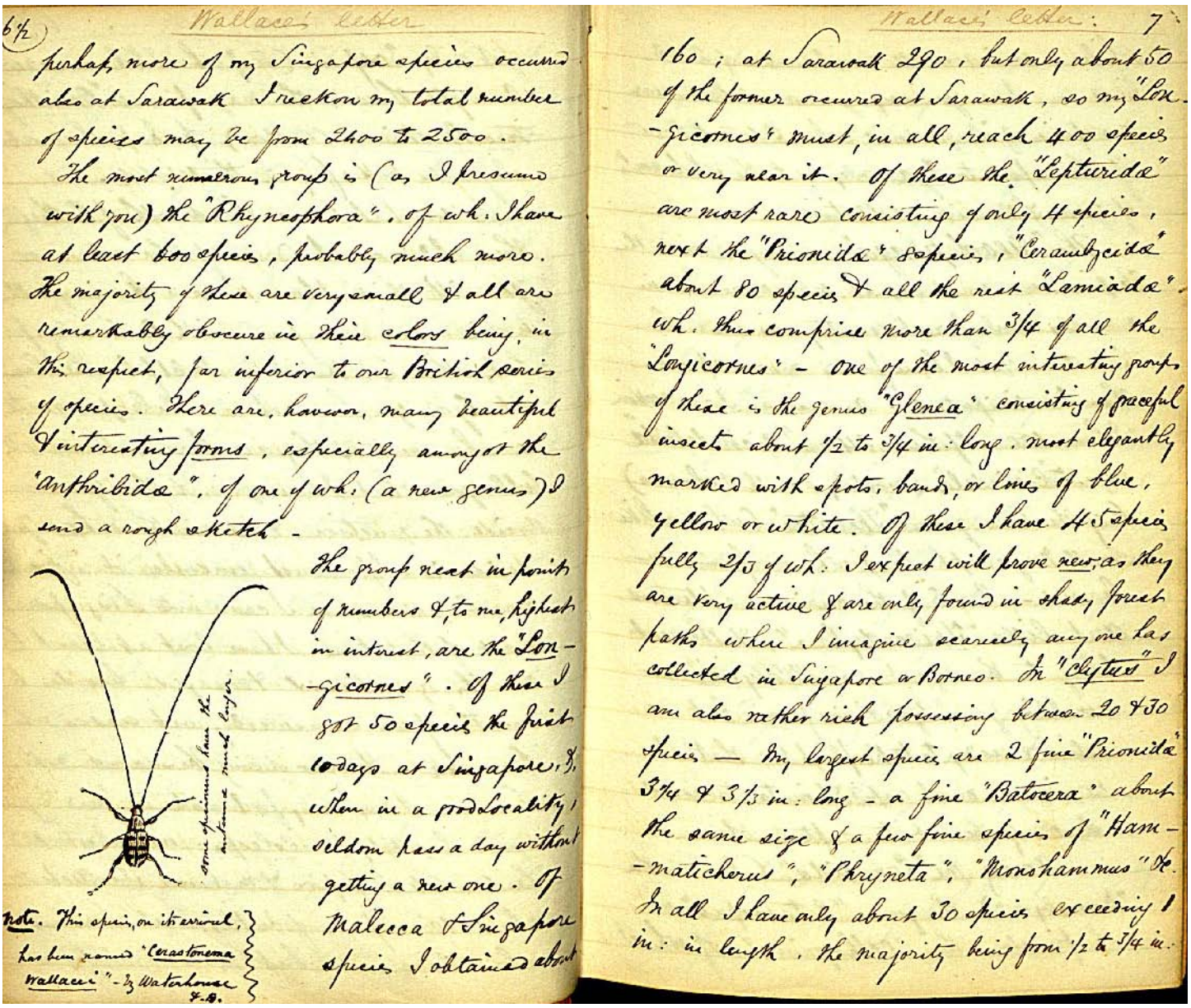
Hoping to hear from you soon & wishing you a happy & successful new year
believe me

Yours sincerely
Alfred R. Wallace



I shall be glad of any butterflies
you have to spare —
Argynnis Aglaia & any
other of the large fritillaries
Hipparchia Galathea &
Thecla quercus
both which I believe are
Leicester species —

I have considerable thoughts of
setting up a Cabinet myself this
winter — I have been thinking how
to have it made the best & most
economical method — How do you
think it would do to have the drawers
made with a groove at the top &
the glass nicely squared to slide in
& fit tight, with a piece at the end
to pinch up the square of the box —
I think it would save the expense
of a separate frame for the glass



Wallace's letter

6½

perhaps, more of my Singapore species occurred also at Sarawak I reckon my total number of species may be from 2400 to 2500.

The most numerous group is (as I presume with you) the "Rhynchophora", of wh. I have at least 600 species, probably much more. The majority of these are very small & all are remarkably obscure in their colors being, in this respect, far inferior to our British series of species. There are, however, many beautiful & interesting forms, especially amongst the "anthribidæ", of one of wh. (a new genus) I send a rough sketch -

Note. This spec. on its arrival, has been named "Cerastomema Wallacei" - by Waterhouse F.B.

The group next in point of numbers & to me, highest in interest, are the "Longicornes". Of these I got 50 species the first 10 days at Singapore, & when in a good locality, seldom pass a day without getting a new one. Of Malacca & Singapore species I obtained about

Wallace's letter: 7

160; at Sarawak 290, but only about 50 of the former occured at Sarawak, so my "Longicornes" must, in all, reach 400 species or very near it. Of these the "Lepturidæ" are most rare consisting of only 4 species, next the "Prionidæ" 8 species, "Cerambycidæ" about 80 species & all the rest "Lamiadæ". wh. thus comprise more than ¾ of all the "Longicornes" - One of the most interesting groups of these is the genus "Glenea" consisting of graceful insects about ½ to ¾ in: long, most elegantly marked with spots, bands, or lines of blue, yellow or white. Of these I have 45 species fully ⅔ of wh. I expect will prove new, as they are very active & are only found in shady forest paths where I imagine scarcely any one has collected in Singapore or Borneo. In "Clytus" I am also rather rich possessing between 20 & 30 species — My largest species are 2 fine "Prionidæ" ¾ & ⅗ in: long - a fine "Batocera" about the same size & a few fine species of "Hammaticherus", "Phryneta", "Monohammus" &c. In all I have only about 30 species exceeding 1 in: in length, the majority being from ½ to ¾ in:

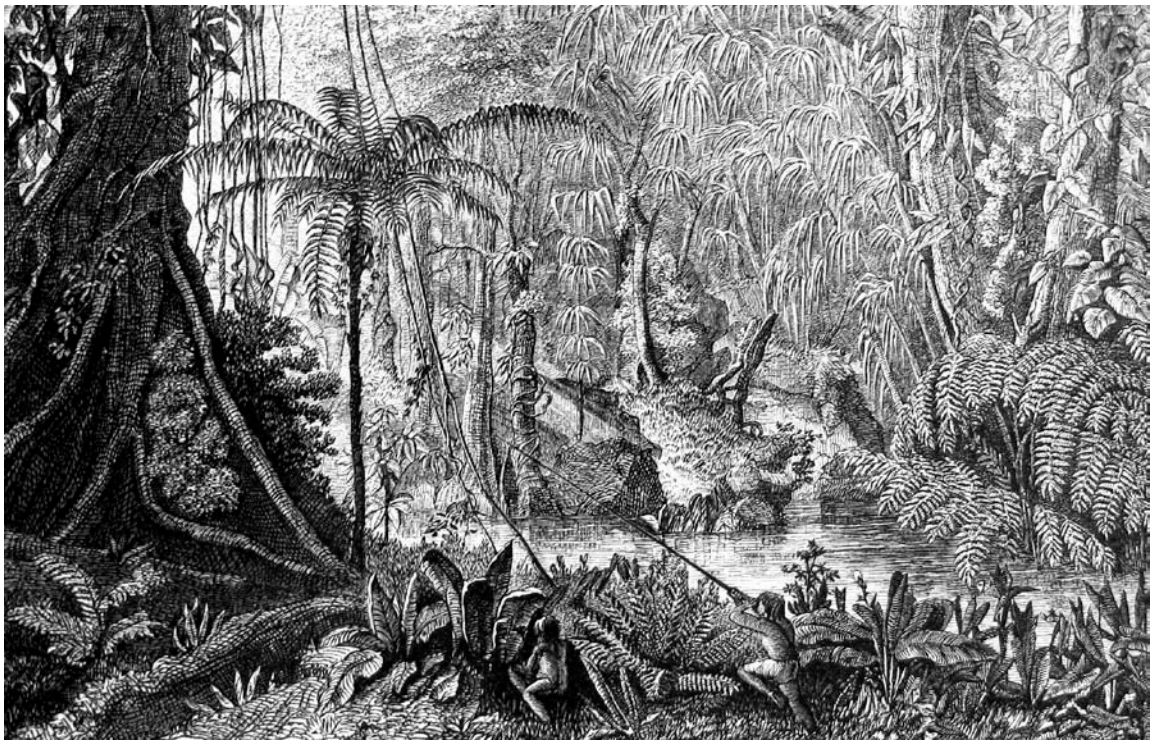
Pictures of letters from Alfred Russel Wallace to Henry Walter Bates, from the Natural History Museum Archives

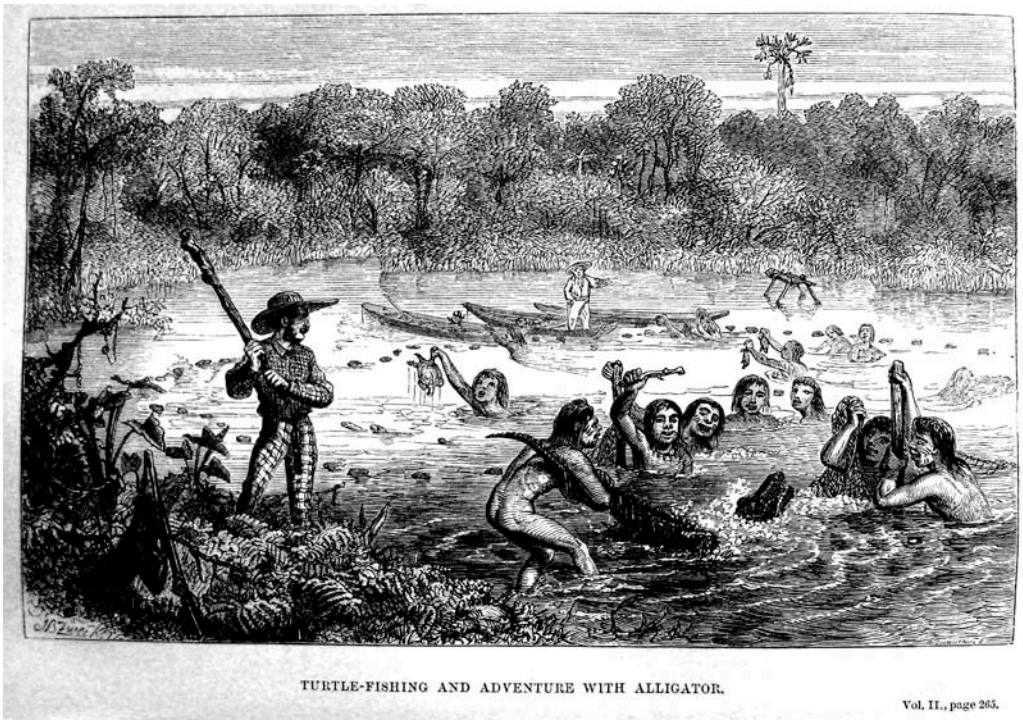
Map of South America



Figure 4.1 The Massive Amazon River System. The main river and its tributaries span more than 15,000 miles. Henry Walter Bates spent most of his eleven years in the Amazon on the main river, while Wallace ventured far up the Rio Negro. Map by Leanne Olds.

Pages from Bates, *Naturalist on the River Amazons* (1863)





TURTLE-FISHING AND ADVENTURE WITH ALLIGATOR.

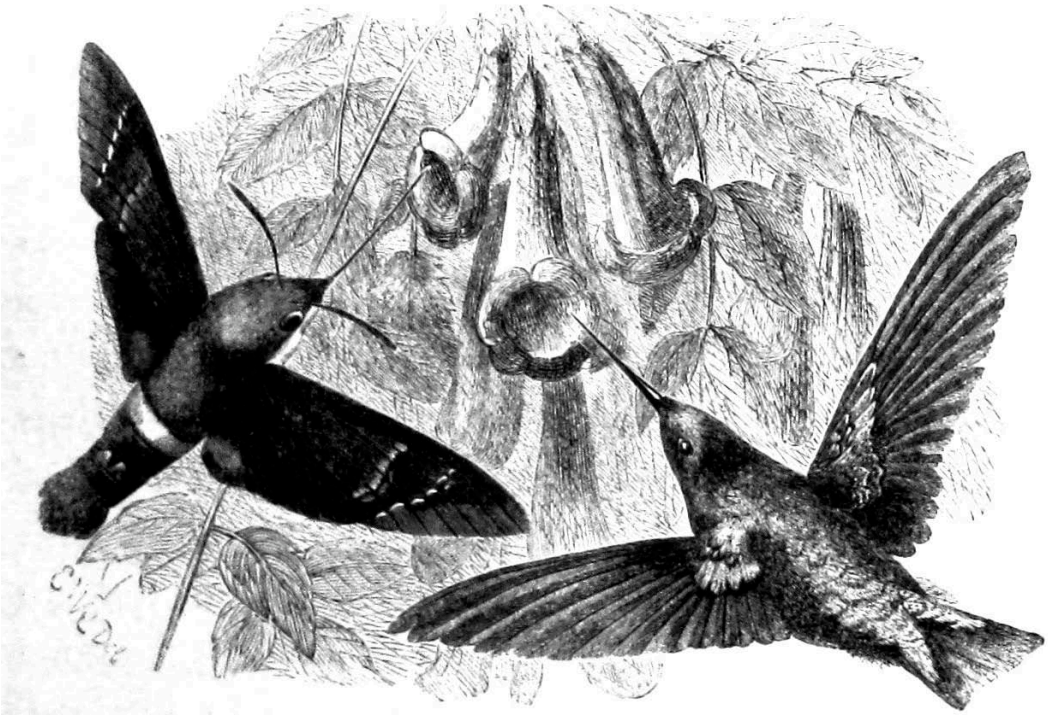
Vol. II., page 265.



ADVENTURE WITH CURL-CRESTED TOUCANS.

Frontispiece to Vol. I.

Humming-birds



Humming-bird and Humming-bird Hawk-moth.

"In January the orange trees became covered with blossom— at least to a greater extent than usual, for they flower more or less in this country all the year round— and the flowers attracted a great number of humming-birds. Every day, in the cooler hours of the morning, and in the evening from four o'clock till six, they were to be seen whirling about the trees by scores. Their motions are unlike those of all other birds. They dart to and fro so swiftly that the eye can scarcely follow them, and when they stop before a flower it is only for a few moments. They poise themselves in an unsteady manner, their wings moving with inconceivable rapidity; probe the flower, and then shoot off to another part of the tree. They do not proceed in that methodical manner which bees follow… but skip about from one part of the tree to another in the most capricious way. Sometimes two males close with each other and fight, mounting upwards in the struggle, as insects are often seen to do when similarly engaged, and then separating hastily and darting back to their work. Now and then they stop to rest, perching on leafless twigs, where they may be sometimes seen probing, from the places where they sit, the flowers within their reach. The brilliant colours with which they are adorned cannot be seen whilst they are fluttering about, nor can the different species be distinguished unless they have a deal of white hue in their plumage…

I searched well at Caripi, expecting to find the *Lophornis Gouldii,* which I was told had been obtained in the locality. This is one of the most beautiful of all humming-birds, having round the neck a frill of long white feathers tipped with golden green. I was not, however, so fortunate as to meet with it. Several times I shot by mistake a humming-bird hawk-moth instead of a bird. This moth (*Macroglossa Titan*) is somewhat smaller than humming-birds generally are ;

r of flight, and the way it poises itself before a flower whilst probing it with its proboscis, are precisely like the same actions of humming-birds. It was only after many days' experience that I learnt to distinguish one from the other when on the wing. This resemblance has attracted the notice of the natives, all of whom, even educated whites, firmly believe that one is transmutable into the other. They have observed the metamorphosis of caterpillars into butterflies, and think it not at all more wonderful that a moth should change into a humming-bird. The resemblance between this hawk-moth and a humming-bird is certainly very curious, and strikes one even when both are examined in the hand. Holding them sideways, the shape of the head and position of the eyes in the moth are be nearly the same as in the bird, the extended proboscis representing the long beak. At the tip of the body there is a brush of long hair-scales resembling feathers which, being expanded, looks very much like a bird's tail, of course, all these points of resemblance are merely superficial. The negroes and Indians tried to convince me that the two were of the same species. " Look at their feathers," they said, " their eyes are the same, and so are their tails." This belief is so deeply rooted that it was useless to reason with them on the subject. The Macroglossa moths are found in most countries, and have everywhere the same habits ; one well- known species is found in England. Mr. Gould relates that he once had a stormy altercation with an English gentleman, who affirmed that humming-birds were found in England, for he had seen one flying in Devonshire, meaning thereby the moth Macroglossa stellatarum. The analogy between the two creatures has been brought about, probably, by the similarity of their habits, there being no indication of the one having been adapted in outward appearance with reference to the other.

It has been observed that humming-birds are unlike other birds in their mental qualities, resembling in this respect insects rather than warm - blooded vertebrate animals. The want of expression in their eyes, the small degree of versatility in their actions, the quickness and precision of their movements, are all so many points of resemblance between them and insects."

Butterflies

The case was furnished by certain kinds of handsome butterflies belonging to the genus Heliconius,* a group peculiar to Tropical America, abounding in individuals everywhere in the shades of its luxuriant forests, and presenting clusters of varieties and closely allied species, as well as many distinct, better marked forms. The closely allied species and varieties are a great puzzle to classifiers; in fact, the group is one of those wherein great changes seem to be now going on. A conspicuous mem-



Heliconius Melpomene.

ber of the group is the H. Melpomene of Linnæus. This elegant form is found throughout Guiana, Venezuela, and some parts of New Granada. It is very common at Obydos, and reappears on the south side of the river in the dry forests behind Santarem, at the mouth of the Tapajos. In all other parts of the Amazons valley, east-

* This genus has long been known under the name of Heliconia: a most inconvenient term, as a botanical genus bears the same name. An author has lately proposed to revert to the masculine termination of the words as first employed by Linnæus (Felder, in the "Wiener Entomologische Monatschrift," March, 1862), and, as I think the correction a good one, I adopt it.

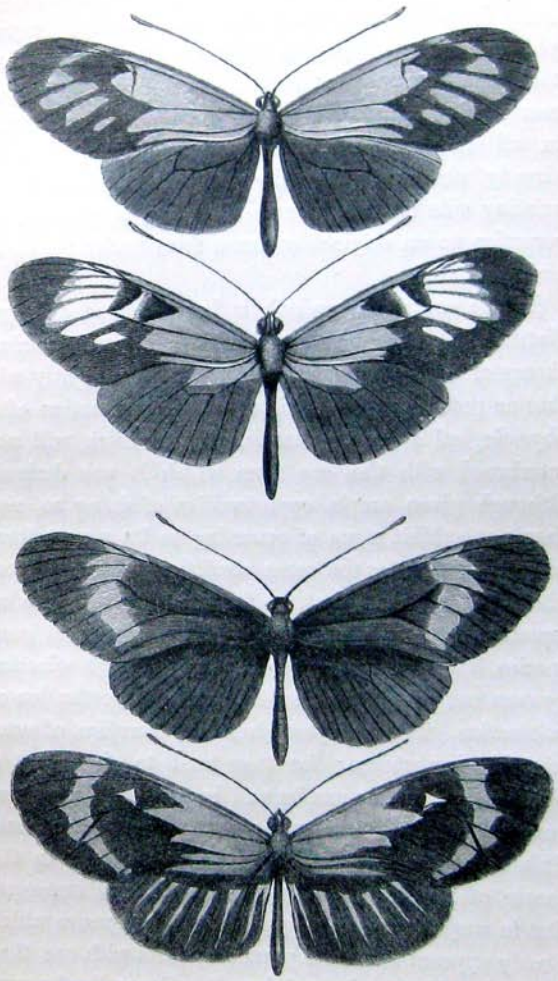
ward to Pará and westward to Peru, it is entirely absent. This absence at first appeared to me very strange; for the local conditions of these regions did not appear so strongly contrasted as to check, in this abrupt manner, the range of so prolific a species; especially as at Obydos and Santarem it occurred in moist woods close to the edge of the river. Another and nearly allied species, however, takes its place in the forest plains; namely, the H. Thelxiope of Hübner. It is of the same size and shape as its sister kind, but differs very strikingly in colours: H. Melpomene being simply black with a large crimson spot on its wings, whilst H. Thelxiope has these beautifully rayed with black and crimson, and is further adorned with a number of bright yellow spots. Both have the same habits. H. Melpomene ornaments the



Heliconius Thelxiope.

sandy alleys in the forests of Obydos, floating lazily in great numbers over the lower trees; whilst H. Thelxiope, in a similar manner and in equal numbers, adorns the moister forests which constitute its domain. No one

who has studied the group has doubted for a moment that the two are perfectly and originally distinct species, like the hare and rabbit, for instance, or any other two allied species of one and the same genus. The following facts, however, led me to conclude that the one is simply a modification of the other. There are, as might be supposed, districts of forest intermediate in character between the drier areas of Obydos, &c., and the moister tracts which compose the rest of the immense river valley. At two places in these intermediate districts, namely, Serpa, 180 miles west of Obydos, on the same side of the river, and Aveyros, on the lower Tapajos, most of the individuals of these Heliconii which occurred were transition forms between the two species. Already, at Obydos, H. Melpomene showed some slight variation amongst its individuals in the direction of H. Thelxiope, but not anything nearly approaching it. It might be said that these transition forms were hybrids, produced by the intercrossing of two originally distinct species; but the two come in contact in several places where these intermediate examples are unknown, and I never observed them to pair with each other. Besides which, many of them occur also on the coast of Guiana, where H. Thelxiope has never been found. These hybrid-looking specimens are connected together by so complete a chain of gradations that it is difficult to separate them even into varieties, and they are incomparably more rare than the two extreme forms. They link together gradually the wide interval between the two species. One is driven to conclude, from these facts, that the two were originally one and the same: the

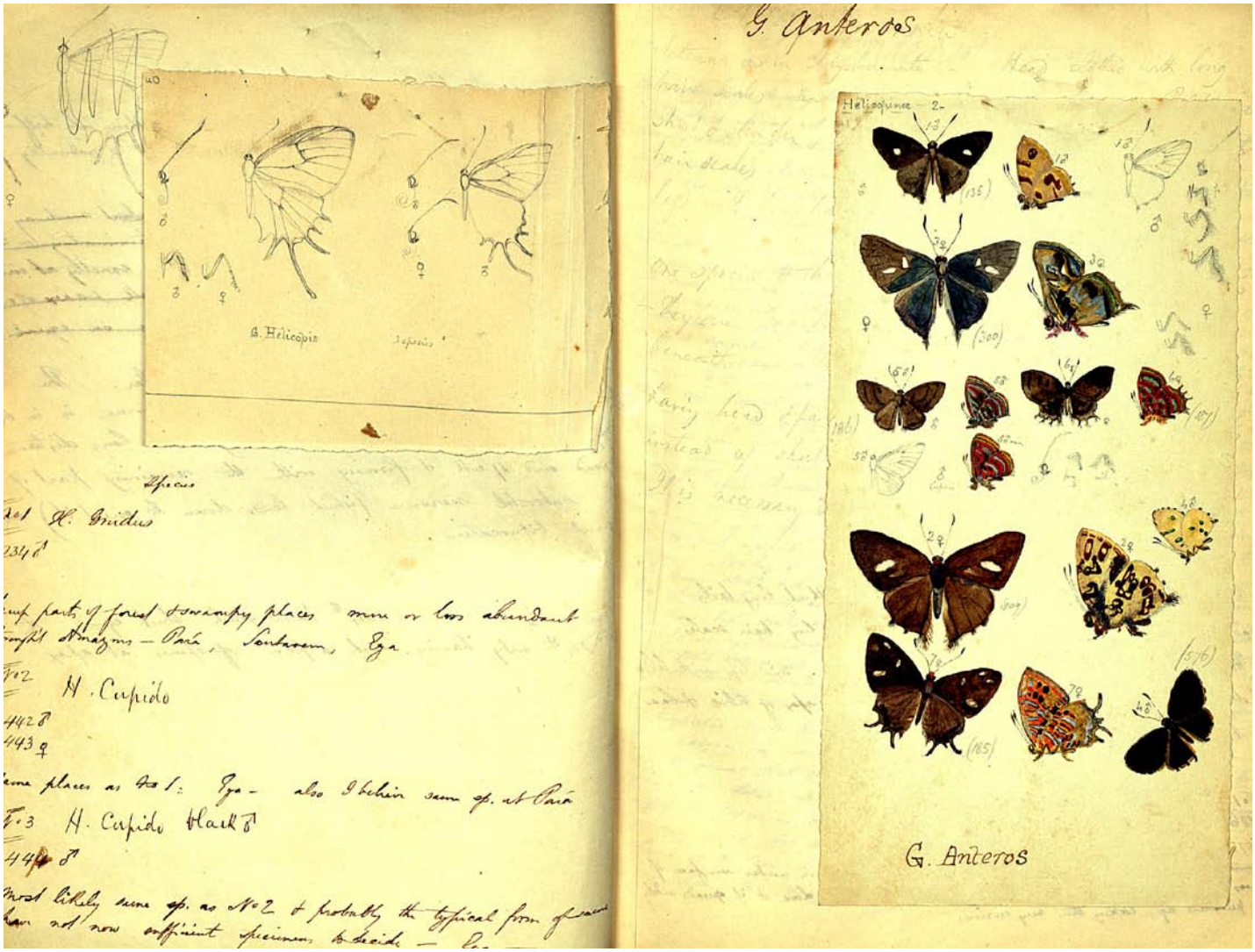


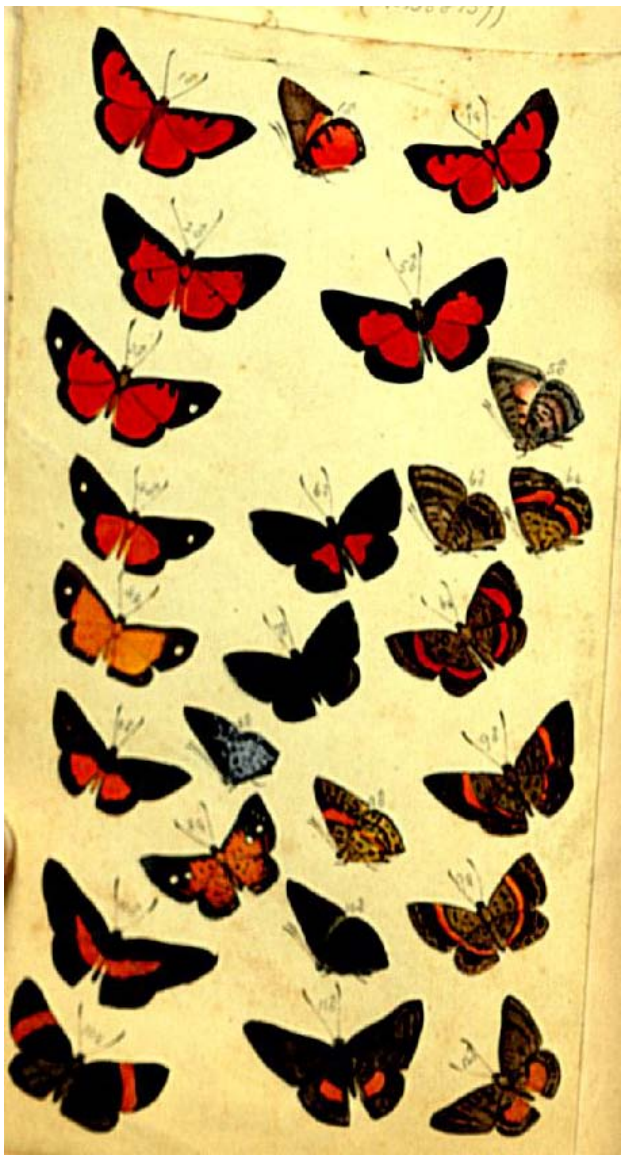
Transition forms between Heliconius Melpomene and H. Thelxiope.

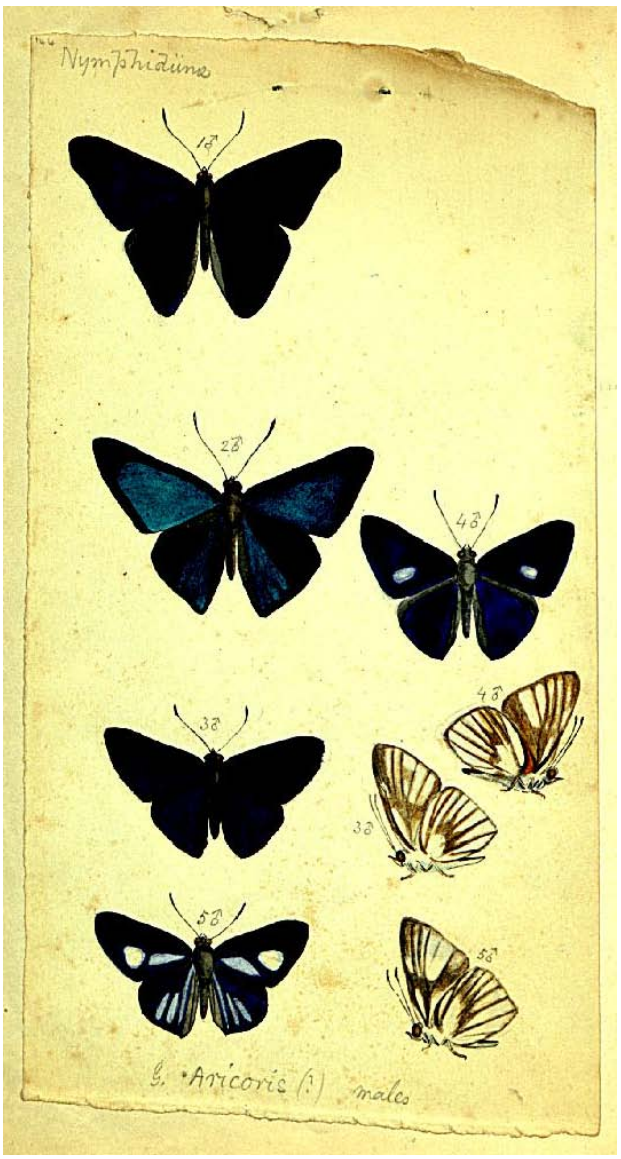
mode in which they occur and their relative geographical positions being in favour of the supposition that H. Thelxiope has been derived from H. Melpomene. Both are nevertheless good and true species in all the essential characters of species; for, as already observed, they do not pair together when existing side by side, nor is their any appearance of reversion to an original common form under the same circumstances.

In the controversy which is being waged amongst Naturalists, since the publication of the Darwinian theory of the origin of species, it has been rightly said that no proof at present existed of the production of a physiological species,—that is, a form which will not interbreed with the one from which it was derived, although given ample opportunities of doing so, and does not exhibit signs of reverting to its parent form when placed under the same conditions with it. Morphological species,—that is, forms which differ to an amount that would justify their being considered good species, have been produced in plenty through selection by man out of variations arising under domestication or cultivation. The facts just given are, therefore, of some scientific importance; for they tend to show that a physiological species can be and is produced in nature out of the varieties of a pre-existing closely allied one. This is not an isolated case; for I observed, in the course of my travels, a number of similar instances. But in very few has it happened that the species which clearly appears to be the parent coexists with one that has been evidently derived from it. Generally the supposed parent also seems to have been modified, and then the demonstration is not so clear, for some of the links in the chain of variation are wanting. The process of origination of a species in nature, as it takes place successively, must be ever perhaps beyond man's power to trace, on account of the great lapse of time it requires. But we can obtain a fair view of it by tracing a variable and far-spreading species over the wide area of its present distribution; and a long observation of such will lead to the conclusion that new species in all cases must have arisen out of variable and widely-disseminated forms. It sometimes happens, as in the present instance, that we find in one locality a species under a certain form which is constant to all the individuals concerned; in another exhibiting numerous varieties; and in a third presenting itself as a constant form, quite distinct from the one we set out with. If we meet with any two of these modifications living side by side, and maintaining their distinctive characters under such circumstances, the proof of the natural origination of a species is complete: it could not be much more so were we able to watch the process step by step. It might be objected that the difference between our two species is but slight, and that by classing them as varieties nothing further would be proved by them. But the differences between them are such as obtain between allied species generally. Large genera are composed, in great part, of such species; and it is interesting to show how the great and beautiful diversity within a large genus is brought about by the working of laws within our comprehension.

Pages from Bates' notebook, from the Natural History Museum collections






Nymphidiine
1♂
2♂
4♂
3♂
4♂
3♂
5♂
5♂
G. Aricoris (?) males

Darwin-Bates Correspondence

Down Bromley Kent

Nov. 22

My dear Sir

I thank you sincerely for writing to me & for your very interesting letter. Your name has for very long been familiar to me, & I have heard of your zealous exertions in the cause of NaturalHistory. But I did not know that you had worked with high philosophical questions before your mind. I have an old belief that a good observer really means a good theorist & I fully expect to find your observations most valuable. I am very sorry to hear that your health is shattered; but I trust under a healthy climate it may be restored. I can sympathise with you fully on this score, for I have had bad health for many years & fear I shall ever remain a confirmed invalid.—

I am delighted to hear that you, with all your large practical knowledge of Nat. History, anticipated me in many respects & concur with me.— As you say I have been thoroughily well attacked & reviled, (especially by entomologists, Westwood, Wollaston & A. Murray have all reviewed & sneered at me to their hearts' content) but I care nothing about their attacks; several really good judges go a long way with me, & I observe that all those who go some little way tend to go somewhat further. What a fine philosophical mind your friend, Mr Wallace has, & he has acted in relation to me, like a true man with a noble spirit.— I see by your letter that you have grappled with several of the most difficult problems, as it seems to me, in natural History—such as the distinctions between the different kinds of varieties, representative species &c.

…

I shall be particularly obliged for a copy of your paper when published; & if any suggestions occur to me (not that you require any) or questions I will write & ask.—

Pray believe me, with respect & good wishes | My dear Sir | Yours sincerely | C. Darwin

King St Leicester, 18 March 1861

Dear Sir

At last the Ent. Society have printed my paper & I am enabled to send you <a> copy according to promise.

I do not know whether the peru<sal> will repay your trouble, & I cannot point out especial passages embodying the facts most useful & interesting to you; the<y> are scattered over the whole,—perhaps the concluding observations & those under the head of P. Hierocles are most to the point.

I think there are about 3 points of interest arising from the review of the species of Papilio—& the genus from the precision of the specific characters & the great amount of material existing in collections is well calculated to illustrate them.— These are

1 The derivation of the Amazonian fauna. I confess I was not prepared for the result to which I was obliged to arrive after a close examination of the species & their distribution—viz: that the Guiana region must <ha>ve been the seat of an ancient & peculiar fauna transmitted through vast lapses of time; & that thence was derived the fauna of the Amazon valley.— Also that it was still so rich in endemic species. Surely I am right in deriving the conclusion that there can have been no great extinction here <d>uring the glacial epoch.

2 The widely different variability of species when under different local conditions in localities widely apart— Let us suppose 4 species A B C D living at localities 1 & 2. A will be not in the least modified: B constant at 1 will be instable at 2: C will have become changed at 2 in all its individuals, but the change is so small that all will admit the difference to be that of a variety: whilst D will have become changed so much more considerably at 2 that every author will treat the form as a perfectly good species. Yet all the points of difference between D1 & D2 are similar to those between B1 & B2 and <C>1 & C2, only they are greater in degree or more numerous

3 The permanency of local varieties after they have become established. It is still the favourite argument of our best naturalists that varieties will always return to their normal form & that they will inter breed & produce fertile offspring. This argument is derived from the observations of varieties produced by domesti<cation>—a false guide—such varieties are too rapidly made, to be compared with the slow alterations of the whole organism which takes place in nature & affects, I have no doubt, at length the reproductive elements.— In the genus Papilio there is a set of local varieties all connected by fine gradations of differences; & yet in one well established case two of these varieties exist in contact & do not show the slightest tendency to amalgamate.— It is a case exactly parallel to what would be if we were to find in the wild state a series of graduated local varieties between the horse & ass;— I thought it likely I should find in the Natural History of the Horse & ass some data to prove the parallel & turned to a paper by Blyth lately published on the

varieties of wild ass. I was surprised to find how little was satisfactorily known on the subject & how uncertain & vacillating is the state of our knowledge of the species & varieties of these conspicuous animals.

With <re>gard to the varieties of species involving modifications of their reproductive elements, a learned entomologist friend of mine, M[r] Baly, has found in the chrysomelidæ, what he calls *specific differences* in the male organs of generation-he finds they <v>ary between very closely allied forms,—but then he reasons I think falsely,—he says that the fact of the difference in these organs proves distinctness of species & thus he is proving to be distinct species forms which all Entomologists had agreed to consider as varieties.— It is very amusing to read (In the proc. Ent[l]. Soc. I think September or October las) that he had received a large series of Donaciæ from N. America,— there were many doubtful forms amongst them & he has applied the test of these organs to prove whether they are distinct species or no.

I hope you will excuse this rather rambling letter & favour me with your opinion on my pap<er> at your earliest convenience

Yours sincerely | H W Bates