

An Angler's Guide to Amino Acids

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Introduction

What's the deal with amino acids (AAs)? After all, pretty much every bait on the market claims to have harnessed the *magical* fish catching power of these simple molecules (although anglers' 'on the bank' experiences have, to date, generally *not* supported their respective manufacturer's overly exaggerated claims!). Having acknowledged these facts, the reality of the matter is that we can now reveal, *for the first time*, that the AA enigma has finally been 'cracked' with regard to crafting effective AA based additives which, in turn, induce an involuntary feeding response among a broad range of fish species (including carp). The underlying science / intellectual property (IP) has recently been patented¹, meaning these findings can, *at last*, be released to the angling public without the fear of unauthorized commercialization. Thus, pioneering anglers should feel free to ramp up the effectiveness of their own baits through capitalizing upon the information contained here, while (for anglers simply wishing to catch significantly more fish *without* undertaking a crash course in biochemistry) a full range of licensed 'off the shelf' (BioSource™ and Impulse™) retail products, featuring these advances, have become, or are set to become, available through a select group of licensed manufacturers².

The bulk of this article is arranged in a Q&A type format, with more general questions (typically submitted by anglers), as well as a review of the angling literature, appearing in Section 1; saving the more detailed scientific proof underpinning the products' claims, as well as a summary of their likely consequences, for Section 2. The idea here is that the average angler will quickly be able to get up to speed on how to best use products featuring the Impulse™ feeding stimulant within their own fishing; with more dedicated 'bait heads' likely finding the latter, more academic, supporting data of significant interest. Thus, questions answered in section 1 are typically linked to one or more detailed follow up Q&As in section 2. Additional resources, including a complete list of references, a glossary and pertinent biographical information, are included in Section 3.

Section 1: The Basics – What is an Amino Acid (AA)?

Proteins, found within both plants and animals, are constructed from amino acid (AA) 'building blocks'. Think of AAs a bit like Legos - there are 20 or so different types, which, when put together in particular sequences, make useful larger structures. In the human body, proteins can be found within muscle and other tissues, while plant proteins are typically found within their seeds or grains. See **More on AAs** in Section 2 for a complete list of amino acids and their respective classifications.

Why are Fish Attracted to AAs?

Simply, fish associate AAs with the presence of food. Every organism, living or dead, animal or vegetable, is 'leaking' AAs into its immediate environment. Don't believe me? Fingerprints left on the pages of a magazine or keyboard can readily be identified by a ninhydrin test - a process that stains AAs blue (so rendering them readily viewable to 'plod'). For aquatic creatures, which have yet to invent the printing press or purchase iPads, their respective AAs dissolve directly into the surrounding water. It is these solvated AAs that are ultimately detected by fish, so allowing them to home in on a potential meal. Importantly, plants and animals have their own unique AA profiles (AA profiles are the resulting 'soup' of AAs generated when the parent protein breaks down) - a fact which allows fish to distinguish between these two general food types. The scientific description of how and why fish are stimulated to feed by specific AAs and/or AA profiles, coined the 'BioSource Interpretation³', furnishes a complete model of AA based feeding stimulation. This important theory is discussed in more detail within **The BioSource Interpretation**, presented in Section 2, thereby providing the reader a complete review of the theories underpinning our groundbreaking Impulse™ and earlier generation additives.

What Makes AA Additives so Effective?

Simply, these products 'ring the dinner bell' - essentially telling the fish there are greater than ~100 times more food items in the angler's fishing area than there actually are! Boilies, corn, pellets, groundbait, even maggots - it doesn't really matter which type of bait or feed is dosed, just so long as the recommended amounts are used. Once unleashed, these baits invoke an involuntary feeding response, or what we (modestly) like to call *The BioSource Effect*, within a broad cross-section of fish species. Without delving too much into the biochemistry, we can save that for the dedicated **How do AA Stimulants work?** and **The BioSource Interpretation** sections below, only certain AAs or AA combinations, at specific concentration levels, will (literally) *make* fish eat. Products containing these patented AA combinations (Impulse™) are now starting to appear on the market. In each case, they are specifically designed to give rise to the all important *BioSource Effect* under typical angling conditions.

Tell Me More About AA Based Products Currently on the Market

AA additives are typically supplied in one of two basic forms: single AAs and their analogues (such as betaine) or AA blends, possessing characteristic AA profiles, typically derived through the digestion of a parent protein (CSL, HVP, HPP, GLM, Multimino etc.). The latter are often referred to as 'liquid foods'.

Single AAs have been shown to work very well as feeding stimulants under laboratory conditions, as illustrated by a variety of academic and other studies⁴⁻¹⁰, *but* have the great disadvantage of being notoriously difficult to 'get right' within a bait⁹⁻¹⁰. Briefly, it's now been proven that single AA embodiments have a *very* narrow range of concentration (or, more accurately, flux) within which they are optimally stimulatory^{3,11}. Thus, it's not really a question of which AA is used, but more to do with attaining an optimal 'leak rate' of this AA from the host bait. The research leading to this radical

discovery was recently patented¹, and forms the basis of proprietary Impulse™, as well as earlier generation products', manufacturing protocols.

In contrast, natural AA blends are *much less* stimulatory than their single AA counterparts, but remain active over a broader concentration range. This leads to an important tip (as often utilized by match anglers 'in the know'), as by simply giving ones baits a quick 'squirt' with an AA blend, such as CSL, they'll immediately be given a minor stimulatory boost - not much, admittedly, but often *just* enough to temp an all important extra fish or two away from the next peg angler... Incidentally, as you may have already guessed, this wrinkle pales into insignificance compared to results recorded by anglers employing more potent single AA (BioSource™), or 'designer' AA blends, such as Impulse™, treated baits within their fishing. These anglers, whose results were recently confirmed by an independent academic study conducted by Sparsholt College¹¹, typically out fished next peg neighbors by a margin of greater than ~2:1¹² during competition!

A third, less common, type of AA feeding stimulant you'll occasionally find on the shelves are what I like to call **Fortified AA Blends**. Simply, they comprise a natural AA mixture, such as CSL or HVP, in combination with a minority fraction of an additional single AA. Such embodiments, which are *only slightly* more stimulatory than the base AA blend, were first discussed by Ken Townley in 'The Beekay Guide to Carp Baits'¹⁰. Here, Ken details how the addition of Betaine to Multimino-PPC makes for an effective bait soak. Numerous bait manufacturers, Original SBS, CC Moore and others, have (literally) stolen a page from Ken's book with regard to the design of their specific in-house fortified blends. Now, without 'letting the cat out of the bag' too much (since Original SBS ceased trading in 2011), it can now be revealed that Original SBS's 'Edge' was basically a blend of powdered CSL spiked with betaine. For those who ever tried 'Edge', they'll likely confirm it was an aptly named product - returning a slight fish attracting/stimulating advantage for its respective users. The most recent fortified blend to appear on the market is CC Moore's Feedstim XP. I'm a little reluctant to divulge this product's actual formula, for obvious reasons (although it should be noted that the composition of any AA blend can easily be elucidated through a relatively cheap GC/MS analysis, with bait companies running such analyses of their competitor's products all the time*). So, let's just say it comprises an HVP base (which is obvious if you ever smell the stuff) with a small amount of an essential AA added - enough said!

While fortified AA blends represent a minor improvement over simpler natural blends they, unfortunately, remain significantly 'out-gunned', in terms of their respective stimulatory properties, when compared to either a correctly utilized single AA embodiment (e.g. BioSource™) or a more complex 'designer' AA blend, such as Impulse™. For those interested in delving more deeply into this intriguing subject, i.e. the scientific reasoning behind how and why AA blends, either natural or fortified, are significantly less stimulatory than either single AAs or specifically designed AA blends, the following **How do AA Stimulants Work?** and **The BioSource Interpretation** sections provide a more detailed review.

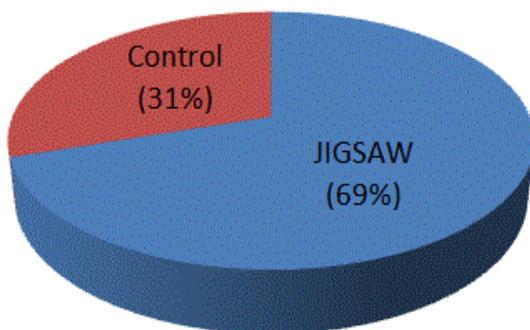
*The fact that bait companies can so easily, and routinely, do run AA analyses on competitive products negates any one of them establishing a real competitive advantage - *unless* the AA formulation in question is patented. This is why both BioSource™ and Impulse™ are protected by IP law¹. However, individual anglers are welcome to read, and even apply, what is contained within these products respective patents¹ - the idea is to prevent unauthorized commercialization, *not* to prevent the spread of essential knowledge among the angling community.

What's the Difference Between BioSource™ and Impulse™?

Simply, products containing BioSource™ are best suited to 'little and often' match fishing style applications, while baits and feeds featuring Impulse™ are better suited to more of a big carp 'bombardment' type approach. The origin of these differences lies in the fact that Impulse™ contains an additional 'site blocking' component which, in turn, does not permit the resultant mixture to become over stimulatory at higher concentrations. Thus, for carpers 'spodding' (or for match anglers 'balling') larger volumes of bait then **Impulse™** should be the 'go to' additive; while for commercial 'match style' carpers, feeding a pot full every 'put in', **BioSource™** is likely the one.

Why Should I Believe the Claims?

I know! I know! As one of literally millions of disillusioned anglers, I can confirm that, in common with pretty much everyone else, we've all become pretty jaded when it comes to the never-ending progression of 'next best super baits'. Essentially every new product coming onto the market claims to have harnessed the *magical* power of aminos in some way, shape or form - but then *totally* fail to deliver. This was one of my primary motivations behind trying to develop a feeding stimulant that *actually* works. Briefly, as an avid angler, Cambridge educated Ph.D. chemist (sorry, mum gets cranky if I don't tell anyone within earshot that her son went to Cambridge...) and now College Professor, I'd become equipped to tackle this problem from a novel, molecular scale perspective. Kind of sad I know, but ask any chemist - we all start to see the world around us in terms of the behavior of atoms and molecules after a while! Thus, by developing a cogent molecular scale model of chemosensory perception in fishes (aka **The BioSource Interpretation**)³, I was able to select suitably stimulatory AAs based on their respective molecular properties - i.e. not just by simply adopting an empirical 'trial and error' method, as is typically undertaken within the angling trade, but by applying a more fundamentally scientific type approach. Cutting to the chase, my novel model of AA behavior was later (independently) proven to be correct^{1,10,12} - I'd achieved the 'Holy Grail' of determining how and why certain AAs and AA mixtures actually *make* fish feed. In other words, to use an analogy, I'd found the goose that lays the golden eggs!



Summary of Sparsholt's JIGSAW™ (Impulse™ prototype) Results

Having a goose that lays golden eggs is one thing, but (as it turns out), convincing people that your eggs are actually made of gold is something *totally* different! Initially, manufacturers, as well as individual anglers (even friends), were often very skeptical about our claims - and given the history of 'magical' products hitting the market over recent years I can't really blame them. However, independent studies conducted at both Sparsholt College in the UK (BioSource™ and Impulse™)¹¹, results shown here, and at St. Olaf College in Minnesota, USA (Impulse™)¹³; in addition to field

trials performed by both SBS Baits (BioSource™) and Richworth (Jigsaw™/ Aminoplex - an early Impulse™ prototype)^{2,12}, clearly corroborate our findings. The Sparsholt results, recorded for multiple anglers using pairs of baits either dosed or not dosed with Impulse™, are summarized by the above pie chart - of all bites recorded, 69% were tallied for Impulse™, with only 31% for standard baits. Readers are enthusiastically encouraged to review these and other results¹², or simply to *try* the baits - fishing otherwise identical 'normal' and Impulse™ dosed baits against each other typically results in a catch rates of *at least* x2 greater for the treated products. Try it, you'll be amazed!

Why Hasn't Anyone Thought of This Before?

In two words - *overwhelming statistics!* Despite a few decent attempts to 'crack' the AA code, no one has previously been able to get it right^{9,14}. This conundrum really epitomizes the differences between the two basic approaches to problem solving - 'trial and error' verses application of the scientific method. Briefly, by way of an example, Impulse™ (a binary AA blend of a specific ratio) is the most stimulatory of *only a handful* of viable AA blends. Now, to arrive at the Impulse™ formula by simple iterative trial and error, as routinely practiced in the industry¹⁴⁻¹⁵, each AA combination (380 permutations) should, minimally, be tested over a range of ~10 component AA ratios and ~10 concentrations. This process then demands that *at least* 38,000 individual trials be conducted - try explaining that to your field testers! There has to be a better way, *and there is* - the scientific method. By designing a model of the fishes' chemosensory apparatus, in terms of how AAs yield a stimulatory response on the molecular level³, we have been able to both predict³ and confirm, via independent experimentation^{11,13}, which particular AA blends, and their respective ratios, are most stimulatory. For those interested in 'popping the bonnet/hood' on the underlying science involved, our chemosensory model of feeding stimulus (**The BioSource Interpretation**³) is discussed further below.

Are the Amino Acids in Any Way Harmful?

Short answer - *NO!* Having said that, their names do seem a little 'chemically', which human nature often associates with potential danger. Example: 'Dihydrogen monoxide' sounds lethal right?* If I now tell you that this chemical's common name is 'water' then it's easy to see the point. Similarly, AAs have similarly 'scary' chemical names, but are equally benign. Indeed, pretty much any pure AA can be purchased off the shelf from any health food shop, with athletes and body builders in particular supplementing their diets with them. We see a similar thing within the farming industries, with commercial pig, horse and cattle feeds often being fortified with specific (essential) AAs. Thus, using an AA enriched bait or feed, such as those containing BioSource™, Impulse™, or any other AA based additives, present no health concerns whatsoever.

* A Michigan Congressman, whom, of course, hails from a state bracketed on three sides by Lakes Michigan, Superior, Huron and Erie, *allegedly* submitted a pork barrel spending proposal aimed at studying 'the alarming levels of *dihydrogen monoxide* within the Great Lakes'. I for one am reassured by 'the alarming level of dihydrogen monoxide in the Great Lakes', but it just goes to show how intimidating formal chemical nomenclature can be....

What's Gone before?

There have been a good number of previous 'near misses' with regard to developing an effective fish feeding stimulant - as well as a great many howling failures! In hindsight, which is 20/20 of course, much of what is discussed below may, in today's terms, seem like common sense. However, it is important to note that these previous studies (and associated 'accepted wisdoms') were not typically conducted and/or developed by trained scientists, but by pioneering anglers, whom, at that time, were often looking into these problems prior to the publication of a number of benchmark scientific studies⁴⁻⁸. First, before moving on to debunking a few popular myths regarding feeding stimulants, let's look at some data and notable quotes from some important angling publications, along with a modern interpretation of their meaning:

*Carp Fever*⁹ is an awesome landmark publication. Here, Kevin Maddocks not only details the hair rig for the first time, but also presents some fundamentally significant data on AAs. Briefly, Maddocks confirmed that essentially any of the 20 common AAs, when leaked into the fishes' environment, will invoke some form of feeding response. Unfortunately, despite a variety of field trials featuring AA impregnated boiled baits, he was unable to translate these findings into a viable carp bait. **The truth of the matter is that we now know that pretty much any AA will make fish feed, but only if it introduced to the fishes' environment at a specific flux or flow rate**^{1,3}. Maddocks' mistake was incorporating his AAs within a base mix that was then boiled - the resultant boilie's impervious skin blocked the AAs from leaking out, thereby not allowing them to reach the necessary threshold flux rate required for stimulation. This problem became even more exasperated for subsequent generations of anglers, as the rise to dominance of 50/50, HNV and fish meal base mixes, which typically generate a very 'tight' skinned bait when boiled, similarly trapped any stimulatory compounds within the boilies themselves. Having said this, there were other subtle clues alluding to what was *really* going on 'behind the curtain' contained within *Carp Fever*⁹. Indeed, Maddocks relates that Duncan Kay had some success with AA impregnated paste baits. Looking back, with that 20/20 hindsight, it now seems obvious that Kay's paste baits worked because the AAs could more easily leak from them. Unfortunately, this observation was not explored any further at the time - had it been, an article similar to this one may have appeared in the angling literature better than 20 years ago*....

*Duncan Kay recommends in *Carp Fever*⁹ that AAs 'should be handled with great care and kept locked away'. This is complete 'tosh', as AAs are in no way harmful to humans, animals or fish. As mentioned above, one only has to look at the annual consumption of literally hundreds of thousands of tons of pure AAs, by way of body building and animal feed supplements, to realize this. I'm not picking on Duncan in particular (the same criticism applies to the Michigan Congressman mentioned in **Are the Amino Acids in Any Way Harmful?**), it's just that through promoting their own (typically inaccurate and/or misleading) scientific *opinions*, such individuals can impede (or even regress) advances made within a discipline - this has, unfortunately, likely been the case with the development of AA based feeding stimulants.

Now, before you run off to the chemists (drugstore US) to buy some AAs for incorporation into your next paste, glug or groundbait, **it should be noted that each AA has an optimal flux rate which is, in turn, governed by the porosity of, and its loading within, the bait itself**¹⁻³ - **if the flux is too low the fish will not be stimulated, while if it is too high the fish will be over stimulated and rendered 'uncatchable'**. Thus, each bait will possess an inherent, very narrow 'Goldilocks zone' of optimal AA loading. Unfortunately, for the individual angler, determining such optimal loading(s), through a simple trial and error approach, would likely take an inordinate amount of time (~200 trials). Happily, the good

news is that the 'Goldilocks zone', corresponding to most popular fishing baits and feeds (boilies, pellets, groundbait, glugs, soaks etc.), have been determined for the most stimulatory single AAs. However, as mentioned above, in order to protect these embodiments from unauthorized commercialization, this information is both patented¹ and proprietary, with specific manufacturing protocols only being made available to licensed manufacturers². Thus, while individual anglers are welcome and encouraged to experiment with AAs of their choosing, a simpler first approach may be to confirm the effectiveness of such baits through 'test driving' some commercial Impulse™ products that already contain AAs at the necessary optimal levels².

Regarding AA blends, *Carp Fever*⁹ provides a tantalizing glimpse into the true nature of this important topic (as discussed in more detail below and elsewhere^{3,13}) Briefly, Maddocks' statement 'one conclusive finding was that those acids which were best on their own, proved to be ineffective when use in combination' definitely infers that specific single AAs in some way 'cancel' with one another when mixed, with the resulting AA blend being rendered much less stimulatory than either of its individual components. This one comment 'lit a fire' under this then 18-year-old 'A' level chemistry student, back in the 1980s, that's been burning to this day! Cutting to the chase, the 'cancelling', (*metamodulatory*), effects seen for AA mixtures have now been investigated¹³, modeled³ and solved³. Thus, we are now in a position where not only can the magnitude of the 'cancelling' effects for any AA blend be predicted, but blends of optimal stimulatory properties may now be construct; or existing blends be optimized though the addition of specific levels of additional AAs. This research ultimately resulted in the development of our third generation product, Impulse™, which is discussed at greater length in section 2.

The Beekay Guide to Carp Baits (authored by Ken Townley)¹⁰ provides a detailed review of a great many carp bait additives and their applications, including AA blends (e.g. CSL, GLM, Multimino, etc.) as well as an AA derivative (Betaine HCl). Betaine is a modified AA, so it behaves in a similar way to other single AAs in terms of its stimulatory properties. Thus, in common with other AAs, Betaine is likely also susceptible to a narrow 'Goldilocks zone' of optimal flux, as discussed above. Indeed, Townley states that, after sharing that he'd taken 'eighteen "twenties" in three trips from two different lakes' that: '(betaine) is one of those products that needs to be used carefully. Put too much in and you'll spoil the effect, but get the level just right and you'll have them *crawling up the rods*'. Although clearly an empirically derived result, Ken is 'spot on' in terms of both witnessing, and qualitatively describing, the 'Goldilocks zone' for betaine. What the author does not disclose is whether or not such results are routinely repeatable - it would most likely appear not, as the wealth of available 'high betaine' pellets, boilies, groundbaits and the like haven't, through improved results, been able to separate themselves from other products in the marketplace. If I were to hazard a guess at the reasons behind Ken's isolated 'eighteen 'twenties" success, that he attributes to betaine, I'd point to the fact that he likely got it 'just right' in terms of the concentration of betaine within his bait and/or bait soak, the number of treated baits used, and the frequency of which these baits were re-feed; as only the correct combination of all these variables would yield the optimal flux of betaine necessary to invoke a stimulatory response. The take home message here is that the use of betaine (as with any single AA feeding stimulant) is something of a double edged sword - get it right and you'll have a bonanza, but consistently getting to this point, via simple trial and error, can be a lengthy and frustrating process. Fortunately, as mentioned

previously, the guesswork associated with establishing the 'Goldilocks zone' of optimal AA flux for single AA feeding stimulants has recently been quantified and patented¹. Simply, products containing the Biosource™ additive consistently give rise to the required optimally stimulatory AA flux rate. Thus, while anglers are encouraged to experiment with single AAs, they should also be aware that a variety of our fully optimized products are now beginning to appear on the market².

Regarding AA blends, Townley discusses a variety of popular commercial products, most notably liquid foods (Sense Appeal range, Liquid liver, Starmino, Minamino, Nutramino, Multimino-PPC and CSL), as well as dehydrated powders (GLM, Liver powder). In each case, these AA mixes are derived through digestion (hydrolysis) of their respective parent proteins, thereby generating a signature 'soup', or profile, of AAs characteristic of the original protein source. Ken states that (for liquid foods): 'they are actually pure foodstuffs in a bottle'; and that 'they are superb attractors as they release 'free' aminos into the lake water around each boilie'. These two comments (while factually correct), in many ways, epitomize the widespread misunderstanding of HNVs and how they relate to AA stimulation. Briefly, liquid foods (powders too) do indeed make for great food sources, providing good amounts of predigested protein. However, for standard boilies: 1). These AAs are generally unable to leak from the boilie due to its impermeable skin, so cannot attain the necessary flux required for stimulation and; 2). The profile of any such AA blend leaking, in diminished amounts, from the bait would not possess the correctly optimized ratio of AAs (as now found in Impulse™) to invoke a strong stimulatory response. Take home message - ***there are no natural 'optimal AA profiles' (GLM, CSL etc.) capable of generating an involuntary feeding response in fish***, despite what it may say on your favorite bait's packaging...

With regarding to powdered AA blends in particular, Ken is obviously a huge fan of GLM, mentioning that: 'This product is high in betaine' and that this chemical 'has been known to incite an active and sustained feeding response when used at exactly the right level in combination with certain amino acids'; adding 'this "exactly right" level and the amino acid combination is a closely guided secret known only to the fish farming industry...' While the first of these statements is accurate, Ken's supposition that fish farmers are guarding some 'magical' AA formula, that induces fish to feed, is a deceptive and factually inaccurate comment that, for me, somewhat diminishes the validity of what, in every other sense, is an excellent book. In reality, aquaculture supplements, such as Aquatrac®, typically comprise 'standard' AA profiles (e.g. HVP). For all intents and purposes, they are practically identical to the natural AA blends used by bait manufacturers and, if truth be told, occasionally get rebranded / repackaged and sold directly to anglers as such. True academic research has generally been limited to Government and University labs⁴⁻⁸, with these studies furnishing important fundamental data that, subsequently, have allowed for a valid model of chemosensory stimulation in fishes³ to be developed. Having said this, the author does somewhat redeem himself through inferring, for the first time, that fortified AA blends (i.e. GLM) are more stimulatory than standard AA blends. Although not explicitly stated, GLM should be considered a 'special case' fortified AA blend because, in addition to possessing a native range of AAs consistent with its AA profile, it also contains, as stated, large amounts of betaine. Thus, betaine (chemical name trimethylglycine, TMG), which is thought to mimic the stimulatory affects of its 'true' AA analogue (glycine)³, essentially skews GLMs AA profile in favor of GLY class AAs - an outcome which leads to marginally increased stimulatory effects. Similarly, as discussed above in **Tell Me More About**

AA Based Products Currently on the Market, Ken also briefly details how Betaine, when dissolved in Multimino-PPC, makes for an effective bait soak. This combination also fits our modern definition of a fortified AA blend, which are, in turn, are known to be slightly more stimulatory than their underlying base blend (Multimino in this case), but less than the supplemental AA used (Betaine). Thus, fortified AA blends can in many ways be considered 'jack of all trades but masters of none' additives, as it is now clear that, even though they will somewhat enhance the nutritional value of a bait, they are unable to simultaneously invoke a strong feeding response. Indeed, only specific 'designer' AA combinations, such as Impulse™, are able to achieve this goal. This significant limitation is discussed more fully in Section 2.

Carp Bait Secrets¹⁴ (eBook), by Tim Richardson, is a bang up to date, broad-based review of pretty much everything and anything a carp angler would ever want to know with regard to putting together their own baits - quite the tour de force! Having said that, and I've admittedly only concentrated my efforts on chapters 8 -10, which directly pertain to AA induced feeding stimulation, I frankly found much of this information to be largely inaccurate. This is not a personal criticism of Tim, who I've chatted with several times¹⁵, but more a comment on the fact that the data he has collected (from other sources), and compiled for these chapters, is typically subjective in nature and of little scientific merit. This is in many ways the 'nature of the beast', as once an idea becomes implanted as 'common wisdom', it just seems to become perpetuated. Basically, more often than not, the authors of angling books and/or magazine articles will play 'fast and loose' with legitimate scientific data, presented within research papers and other publications, for their own ends. Thus, the conclusions they draw, which are generally based more on intuition than any type of formal scientific training or logic, are typically both inaccurate and misleading. The take home message here is that 'a little bit of knowledge *really* is a dangerous thing', and that such analyses should really be left to professional chemists and/or biologist more familiar with the underlying concepts. In order to put the record straight, here are a few classic 'clangers' from *Carp Bait Secrets*¹⁴ (and elsewhere), along with their respective corrections:

'I get the impression that certain carp essential amino acids in your bait vary in their ability to trigger carp into feeding, depending on many variables, so it is best to include the widest range, to cover the most likely temperature and concentration stimulation conditions, e.g. day/night, hot/cold, acid/alkaline pH'.

- First, we need to get past the basic and widely held misconception that only specific AA profiles, or 'ranges' (above), can stimulate fish to feed under different conditions - this is definitely NOT the case. AA induced feeding stimulation, under *any* ambient condition, is all about managing the flux of a specific class of AAs emanating from a bait. Including AAs outside of this respective group within any blend is counterproductive, as dissimilar classes of AAs will effectively 'cancel' one another's stimulatory properties, thereby significantly diminishing the overall potency of the resulting mixture. This basic statement describes, in a nutshell, what 'chemosensory stimulation in fishes'¹³ is really all about, and is discussed in more detail below.

-Second, it is important to recognize that essential AAs are NOT directly correlated with AA initiated feeding stimulation. Anglers often assume that, because 'low quality' feeds are often deficient in one or more essential AAs, the mere presence of these specific AAs within *other* foodstuffs will immediately

stimulate fish to feed on this respective food. This is certainly NOT the case and, in many ways, such thinking epitomizes the cross-contamination of these two independent theories. As mentioned throughout this report, pretty much any AA (under specific conditions of flux³) can be utilized as a feeding trigger, not just essential AAs.

'Amino acid 'ionization' in water (solution), is very important for the carp to detect them, to stimulate feeding, in different water temperatures and pH levels'.

- First, all ionic materials (salts, acids, bases) undergo ionization in water - it's the fundamental mechanism by which they dissolve, with AAs being no exception. However, saying that AAs essentially stimulate fish by ionizing water is a bit like saying a key can only unlock a door if it's painted blue. In reality, it's the grooves in the key's shaft (size and chemical properties of the AA's side chain) that engage the lock (elicit a stimulatory response), *not* the fact that it's painted blue (dissolved). This fundamental concept is discussed fully in section 2.

-Second, it's a recurring theme throughout this document, but bears repeating here - AA induced feeding stimulation is all about generating an exact flux, or flow, of specific AAs from an angler's bait. Now, if the AAs in question become 'trapped' inside a bait, through generating an impervious 'skin' through boiling, there is no way they can then escape (i.e. become solvated) from the bait at sufficient a rate to elicit a stimulatory response. Thus, we should make a clear distinction between 'encapsulated' and 'mobile' AAs - encapsulated AAs, associated with 'tight' 50/50, fishmeal or HNV baits, cannot stimulate fish to feed; while mobile AAs, either incorporated within 'looser,' more porous, bird food type baits, or introduced to virtually any bait via an appropriate glug or soak, can generate a stimulatory response.

Ultrabite Pheromones - Oh my! Do you, like me, remember that whole *Ultrabite* marketing campaign from the 1980s? It seemed, at the time, that every tackle shop from Lands End to John O'Groats had a box of biochemical style phials at the counter, the contents of which were, in turn, guaranteed to attract fish. Basically, it had been shown, by researchers working at CEFAS, that specific sex pheromones *will* actively attract fish. *However*, what was not mentioned was that, upon arrival in target area, the fish would then have absolutely no interest in feeding (just spawning!). It's common sense - I don't know about you, but if, back in the day, an attractive girl at a night club whispered 'let's go back to my place', then I'm not going to stop for a kebab en route! Although something of a marketing fiasco in the UK, Ultrabite containing baits can still be purchased in the USA (Trigger X) and Japan (Marukyu), where, I'm guessing, it's not commonly known that Ultrabite doesn't really work as feeding stimulant...

The HNV Buffet?*

Everyone and their brother seems to have an opinion on High Nutritional Value (HNV) baits (with such debates, as mentioned immediately above, often spilling over into the realm of AA induced feeding stimulation), so it's important to get to the bottom of how these two concepts are, *or are not*, related. First, recall that the essential premise of HNV theory is that fish instinctively 'know what's good for them' and will, consequently, actively select out HNV offerings over other food sources^{9,10,14-16}. This is definitely a hot button issue among carp anglers with what, at times, often seems like two highly vocal '*yes they do!*' and '*no they don't!*' camps trying out shout each other. Speaking (quietly) from an impartial scientific perspective, there seems to be little concrete evidence supporting the claims of either group. However, if I were pressed to offer a few comments, based on good old-fashioned common sense, coupled with a little chemical intuition, it would be these**:

1. Don't believe all of the so called 'science' behind HNVs - there's some pretty 'off the wall' stuff out there (*all carp are diabetic, carp don't eat carbohydrates etc.*), which is mostly inaccurate and opinion driven, i.e. lots of shouting...
2. HNVs definitely catch fish, *lots of fish*, that can't be denied. However, for HNVs to get established they often have to go into a water over an extended period¹⁶ - do this with any decent bait (i.e. pre-baiting) and you'll typically catch a 'shed full'... Having said that, HNVs do seem to have more 'legs' than other baits, supporting the claim that, after they've been accepted as a food source, carp do indeed feed on them preferentially. The take home message here is that HNVs are more of a campaign bait - great if you fish the same water year in year out, but not so good for 'hit and run' carping, such as on day ticket waters and commercials etc.
3. Creatures of all types, including humans, are hard-wired to 'binge' on *high calorie* (i.e. HNV) foods*. This evolutionary artifact, in humans at least, is a side effect of our former prehistoric lifestyle - during times of plenty we are conditioned to store as many calories as possible, so to tide us over through times of lean (this also helps to explain why evolution's course has rendered high calorie foods, such as sugary cakes and greasy burgers, and, dare I venture, top quality boilies, so darn tasty!). Thus, maybe the assumption that carp eat HNVs 'because they are good for them', should actually be changed to 'because they are preferentially inclined to eat foods of higher caloric content due to evolutionary factors'...

Check this last hypothesis out the next time you go to an 'all you can eat' buffet - you'll not see too many people returning to their tables with small salads, it's usually a pile of fatty meats, various deep fried items, and a big 'ol piece of cake - all washed down with a bucket of sugary coke! We're smart enough to know better than that, but our genes are making us stash these bonus calories for a rainy day - *which then never comes*. It should then come as no surprise that around 1 in 3 Americans are now classified as being morbidly obese and/or having contracted type 2 diabetes though over indulgence - we just can't help ourselves. We see similar 'buffet' type behaviors within the animal kingdom too. For example, in times of plenty Grizzly bears will gorge themselves *only* on the brains of salmon they snatch from

streams (the brain is essentially 100% fat), while in leaner times they will eat the whole salmon - fins 'n all! Similarly, our bear friends will endure literally hundreds of bee stings for the sugary rush associated with a mere pawful of pure honey... Thus, my argument is a simple one: should carp be presented with an excess of various feed types, they *may*, based on their genetic predisposition, preferentially consume those containing the most calories - typically HNV baits*. Thus, for 'buffet' type waters, that see *a lot* of bait, the HNV argument isn't so farfetched after all. Indeed, it actually helps to explain why the waistlines of carp (and most Americans) seem to be growing at exponential rates, and who knows, maybe why *some* of those 'porky' carp are developing diabetes too....

*HNV baits *are typically* high in calories, particularly when compared to the carp's natural diet. They also contain relatively higher amounts of protein (4 calories/gram) and fat (9 calories/gram) than comparable 50/50 or bird food type baits, which have a higher fraction of carbohydrates(4 calories/gram) and fiber (<1 calories/gram). This is *not* to say 'proper' HNV baits are in any way analogous to 'junk food' - more like a large number of high quality, 15 mm diameter, Sunday roasts! Eating three roast dinners a day in place of regular meals will quickly pack on the pounds - for weight gain in fish it then seems to be all about the *quantity* of quality baits being *preferentially* consumed.



Calories! Calories! Calories! *We just can't help ourselves.....*

One of the more subtle features of HNV theory, and this is where it crosses over to AA feeding stimulants, is the incorporation of essential AAs within such baits. Briefly, it is further postulated that carp can somehow 'sense' the absence of essential AAs, so will preferentially feed on baits containing them¹⁴. Since this idea was originally borrowed from the animal feed industry, it's immediately rendered something of a self-defeating argument. Simply, very cheap, low quality animal feeds must be fortified with 'missing' essential AAs to ensure that livestock will put on weight quickly (essential AAs get their name because they are essential requirements for protein / muscle synthesis). This does *not* apply to HNVs, which, by definition, contain a high fraction of quality proteins which, in turn, possess well balanced AA profiles - it's the protein equivalent of drinking a pint of fresh squeezed orange juice and then popping a vitamin C tablet!

Where we do see direct similarities between HNVs and AA based feeding stimulants is the inclusion of essential single AAs, or simple essential AA blends, within the baits themselves. However, the associated 'stop right there' argument has already been made. Maddocks⁹ (see above) showed that when AAs are incorporated into a standard boilie they, unavoidably, become encapsulated, so then cannot traverse the bait's impervious skin. Thus, solvated stimulatory AAs (which must first leak from a porous bait to be effective), although chemically identical to those trapped inside, inevitably perform two very dissimilar

functions - solvated AAs are detected by the carp's olfactory system, leading to feeding stimulation, while the encapsulated counterparts are merely treated as digestible foodstuffs.

Interestingly, the likely subtle selectivity of carp towards of HNV baits has been shown, during partner manufacturers² and others trials¹², to be completely overwhelmed by the 'eat me now!' food signal generated by Impulse™ treated feeds. Indeed, during testing, a prototype bird food based 'B' boilie (never before seen on 'The Avenue') promptly accounted for this venue's record fish; while Richworth testers recently achieved 3rd place (out of 160 teams) at the 2012 World Carp Championship. This latter result is most gratifying, as their prototype Impulse™ treated baits out fished other manufacturers top end products for *literally* miles around (25 and 30 pegs respectively in either direction)! We also have good reason to believe that BioSource™ *unofficially* helped a certain angler take second place at a recent CIPS World Match Fishing Championships - I'm not going to mention any names, but *we know who you are!*

Take home message: anglers using either BioSource™ or Impulse™ treated bait and feeds should feel confident fishing new waters with such products 'from the off', as there really is no need to 'get on' the in vogue bait. Similarly, for anglers wishing to continue using their favorite baits, a full line of Impulse™ glugs, soaks and other bait treatments are, hopefully, destined to hit the shelves soon².

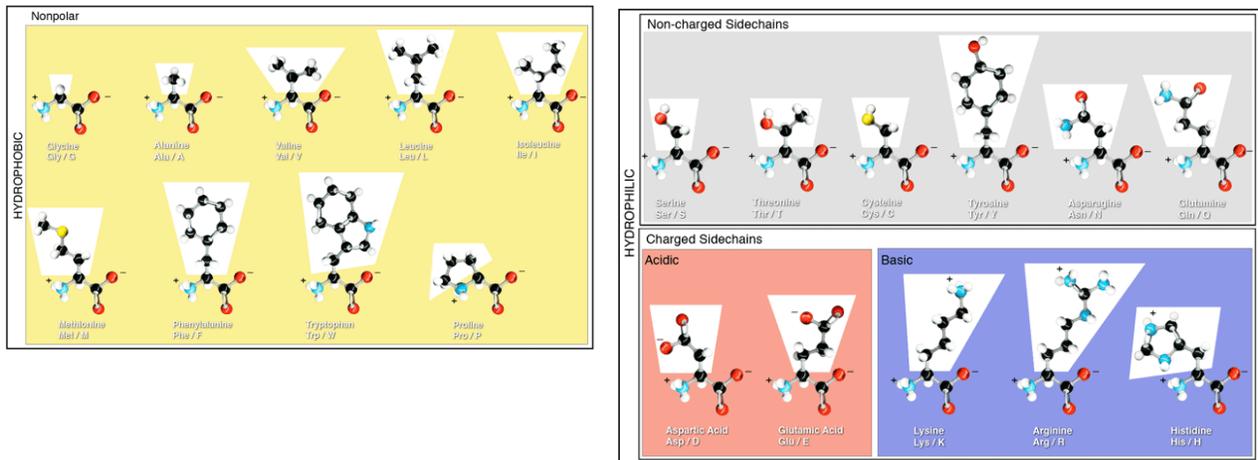
**Unlike the bulk of this document, which comprises a detailed discussion of AA feeding stimulation based on a proven, quantitative understanding of the underlying chemistry^{1,3-8}, the above HNV discussion presents a personal interpretation of others largely qualitative results and ideas, *and should be viewed in that light.*

Section 2: Details

Welcome to Nerd Fest 2020! Unless you took science classes in high school, appreciate the humor of 'The Big Bang Theory', or (like me) pretend to understand better than 1% of what Stephen Hawking was talking about in either his books or on PBS (the American version of BBC 2), then the following might be a little confusing. However, if you're a bit of a 'bait head' please read on, as we've really got to the bottom of how and why AAs work...

More on AAs:

Proteins are comprised of amino acid (AA) 'chains', with each individual AA comprising a 'link' in said protein chain. There are 20 naturally occurring AAs, as illustrated by the following figure:



The 20 or so natural AAs, detailed above, can be better subdivided into four more fundamental categories based on the nature of their respective side chains: Acidic (A), Basic (B), Long Neutral (LN) or Short Polar (SP)³. This is slightly different than the four groups portrayed in the figure but is more consistent with recent academic literature⁴.

How do AA Stimulants Work?

Simply, single AA stimulants (BioSource™) and more sophisticated AA mixtures (Impulse™) invoke an involuntary feeding response by, respectively, engaging a specific fraction of the fishes available 'BS' or 'BS' and 'NS' type AA receptor sites - too few and the fish will be under stimulated, while occupying too many will result in overstimulation. These products generate an optimal level of site occupancy by either 'washing' stimulatory AAs over the fishes receptors with the correct concentration (BioSource™); or by mixing a stimulatory AA with patented 'site blocking' species, which, in turn, then generate an optimally diluted 'saturation coverage' of stimulatory AAs at higher concentrations (Impulse™)³. These

novel discoveries and associated inventions are both significantly more effective, as well as radically different in design, than current AA blend style attractants/stimulants currently on the market, as is discussed fully below.

Background: As shown by the following table, the AA profiles of plant based proteins are generally rich in 'LN' and 'SP' type AAs, while meat and fish proteins typically contain a higher fraction of 'B' type AAs:

Amino acid	Food group				
	Animal mean (± SD)	Cereals mean (± SD)	Legumes mean (± SD)	Nuts/seeds mean (± SD)	Fruits/vegetables mean (± SD)
No. Samples	1,726	170	153	153	572
ISO (LN)	46.7 (4.7)	39.8 (4.6)	45.3 (4.2)	42.8 (6.1)	38.5 (10.8)
LEU (LN)	79.6 (6.0)	86.3 (26.3)	78.9 (4.2)	73.5 (9.0)	59.1 (19.6)
LYS (B)	84.3 (7.1)	30.5 (9.8)	67.1 (3.8)	43.5 (12.7)	49.2 (13.3)
ALA (SP)	74.9 (8.2)	83.0 (9.2)	84.9 (6.3)	88.0 (16.9)	64.0 (18.4)
THY (LN)	43.4 (2.6)	33.6 (5.4)	40.0 (3.3)	37.9 (5.4)	35.1 (8.7)
TRP (LN)	11.4 (1.5)	12.1 (3.3)	12.3 (2.4)	15.4 (4.6)	10.8 (3.9)
VAL (LN)	51.2 (5.6)	51.1 (6.9)	50.5 (4.0)	55.6 (10.3)	45.9 (12.6)

Now, all-natural AA blends (such as CSL, Multimino etc.), as well as the more generic profiles shown above, are known to be only *very slightly* stimulatory. This key observation can be directly traced back to two specific facts:

1. For any natural AA blend, there will always be a slight excess of a specific 'long neutral' (LN), 'short polar' (SP), or 'basic' (B) class of AAs within the parent protein's profile. As mentioned above, plant and vegetable proteins are typically rich in either 'LN' and/or 'SP' type AAs, with meats typically yielding a higher proportion of 'B' type aminos.
2. The remaining, approximately equivalent, quantities of neutral (SP, LN) and charged (A, B) AAs, within the respective profile, give rise to approximately equal yet opposite stimulatory signals, which then 'cancel' or, more scientifically speaking, undergo metamodulation^{3,13} (this cancelling effect is discussed in more detail below within **The BioSource Interpretation**).

Taking these two effects together, we can now see why AA blends possess stimulatory properties essentially identical to those of very weak single AA solutions - it's all due to the 'non-cancelling' slight excess of a single AA class within the food's profile. Bingo! Example: consider an AA blend comprised of 50.5% 'LN' type AAs and 49.5% 'B' type AAs - equal amounts (49.5%) of each respective AA class will cancel, leaving a net of 1.0% 'LN' type AAs free to illicit a stimulatory effect. Unfortunately, this excess 1%, *in real terms*, is far less than generated by single AA component additives, such as BioSource™. Example, if you add, say, 50 g of any neat AA to a kilo of bait you get a 5% loading. Now, if you add 50g of the AA blend detailed above (which has an extra 1% of stimulatory AA) to a kilo of bait you only *really* add an extra 0.5g of excess stimulatory AA - an amount that would yield a stimulatory effect ~ 100x smaller than a single AA embodiment of the same loading!

It doesn't get much better for fortified AA blends either, as similar arguments to those presented immediately above also apply. For example, if a natural AA blend is 'fortified' via the addition of, say, an extra 10% by weight of a single AA (like adding Betaine to CSL, as per Original SBS's 'Edge'), the result is that, for the same 50g of additive per kilo of bait, a net excess of only 5g (0.5%) of stimulatory AA is generated per kilo of bait, which would yield a stimulatory effect ~ 10x smaller than the corresponding single AA embodiment - a little better than a natural blend, but still not BioSource™ numbers!

Additionally, without delving too much into the details, fortified blends are also plagued by a host of other of problems. First, because a specific threshold flux of stimulatory AA must be attained in order to invoke an involuntary feeding response, an extremely high loading of fortified AA blend (approaching 50% by weight) must be added to the bait - an entirely impractical situation! Second, because different AAs have dissimilar solubilities they will dissolve / leach from the bait at different rates. Thus, the bait will essentially 'pulse' AAs of different solubilities over time, meaning that there will likely be overlapping periods of both over and under stimulation, neither of which help to catch fish! Given these facts, fortified blends, although looking good at first glance, should really be considered the 'Robin Reliants' (3 wheeled cars, US) of the additive world. In much the same way as these notorious vehicles fail to combine the economy and maneuverability of a motorcycle with the performance and stability of a car (recall BBC's *Top Gear!*), fortified blends are both impractical from the dual standpoints of possessing both limited stimulatory properties and severely skewed AA profiles (i.e. are no longer 'balanced', as preferred by HNV protagonists^{14,16}). The take home message is clear - 'don't be a plonker Rodney', avoid fortified AA blends if at all possible...

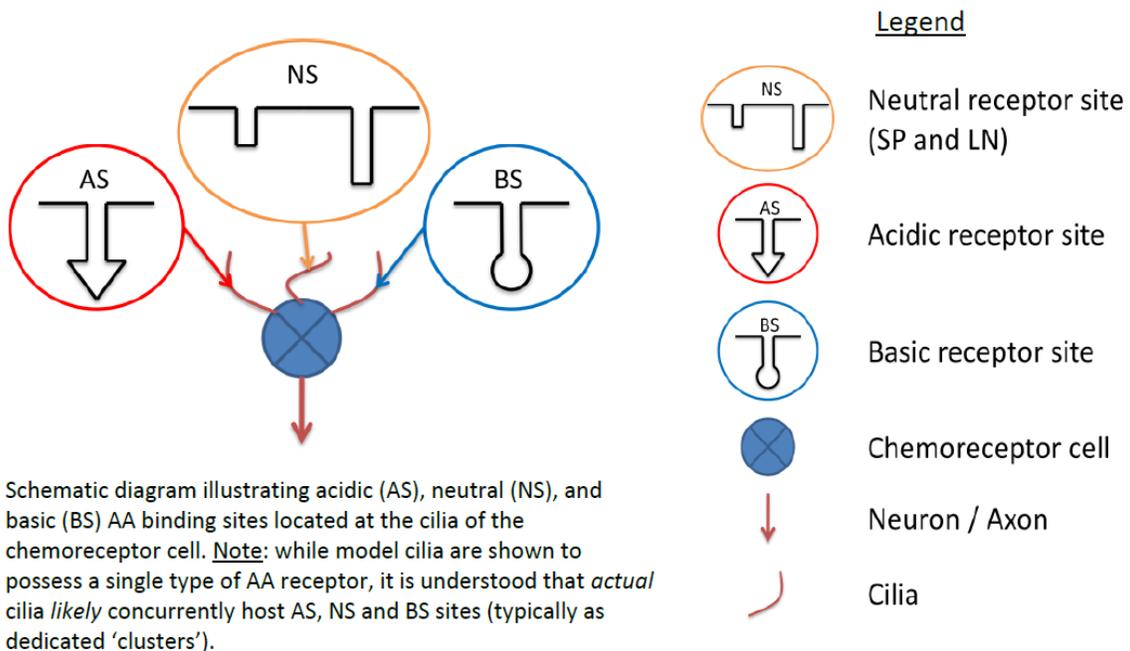


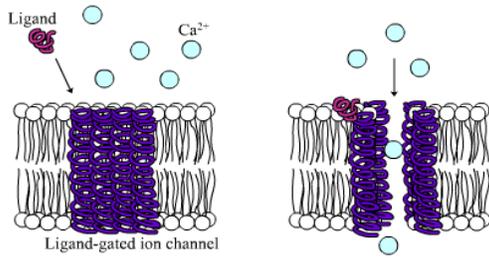
Advice: 'OK, so what's the answer?' you're saying. Simply, a boilie (or other feed), that is required to be both optimally stimulatory and HNV, can be created by following two simple rules: 1). Use a quality bird food base mix (i.e. something that contains ground seeds or other coarse textured edibles, so to promote dissolution and leaching of AAs from within the feed). This base can be further enhanced through the addition of quality whole or *partially* digested proteins (*not* 'free AA' liquid foods!), but should always contain no less than around 15% by weight coarse ground ingredients. 2). Supplement the base mix with the recommended loading of either a concentrated Biosource™ or Impulse™ based additive (available from select manufacturers)² - this will ensure an optimal flux of stimulatory AAs is

generated by the bait when wetted. Now, given these tips, an obvious temptation might be to say: 'right, I'll just put more single AAs in my favorite bait'. While this sounds like a good idea (*and in theory it is*), in practice this has proven to be next to impossible to get right - see **What's Gone before?** (above) and **The BioSource Interpretation**, below, for more details. This is not to say that people haven't tried^{9,10,14} - we've probably all 'had a go' at adding betaine to our baits or simply trying 'high betaine' pellets and/or other 'amino' containing feeds. The reason these products don't typically work is that single AA stimulants only function correctly within a *very narrow* concentration window which, under angling conditions, is next to impossible to identify, achieve and maintain through simple trial and error. Thus, anglers wishing to simply catch more fish 'right out of the gate' (so avoiding a lot 'guesswork related frustration') are highly encouraged to give our partner manufacturers² products a look first.

The BioSource Interpretation³

To fully understand AA induced feeding stimulation, one must first grasp the concepts of how AAs are first detected, how this process then generates nerve impulses (which ultimately travel to the fish's brain), thereby signaling the presence of food. This whole scheme is summarized by the following diagram, and in more detail below:





Now, 'strap in' as thus gets 'sciencey' pretty quickly... First, the fishes' chemosensory apparatus, summarized above, can in many ways be compared to a simple rubber glove. The glove's fingers (cilia, which are in contact with the organism's environment) have a thin 'skin' (plasma membrane) through which either Na⁺ or K⁺ ions can pass via dedicated ligand gated ion

channels (LGICs). These respective LGICs are opened through the adsorption of specific classes of AAs (ligands), emanating from the food source, at the surface of the plasma membrane. Now, once these ions have traversed the plasma membrane, via their dedicated LGICs, their subsequent concentration difference across this barrier ultimately creates a threshold voltage which, in turn, triggers the chemoreceptor cell to send a 'food here!' nerve impulse to the fishes brain.

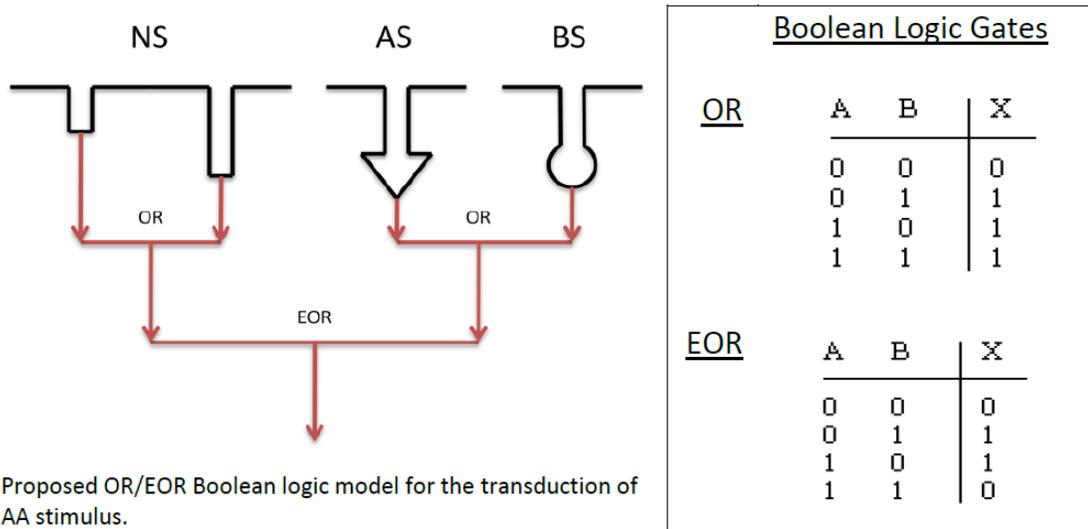
The central hypotheses of **The BioSource Interpretation**³ is that the metamodulation ('canceling') of feeding stimulus, as observed for AA mixtures, and qualitatively discussed above, is directly attributable to the fact that charged (A,B) and uncharged (SP, LN) classes of AAs only allow only for dedicated (Na⁺ or K⁺) LGICs to be activated, respectively. **So here's it is!** The opening of *just* Na⁺ channels, say, through the adsorption of only charged AAs, will generate a *positive* threshold voltage across the cilia's plasma membranes; while the activation of *only* K⁺ channels, by neutral AAs, will give rise to a *negative* threshold voltage. In *either* of these individual cases the chemoreceptor cell will send a nerve impulse to the brain, as only the magnitude, not the polarity, of the voltage signal arriving from the cilia is physiologically significant. Now, consider an AA blend containing approximately equal amounts of both charged and uncharged AAs. In such a case, both types of ligand gated ion channel become activated, generating voltages of similar magnitude *but* of opposite polarity - the result is a voltage cancellation. Thus, because neither a net negative nor positive potential difference above threshold is generated within the cilia, the chemoreceptor cell is not triggered - indicating the AA blend in question has metamodulated (cancelled) the overall stimulatory response.

Reduced Summary of AA Classes and Associated Binding Sites³

<u>AA Class / Binding Site</u>	<u>Assignments</u>
Acidic (A)*	ASP, GLU
Basic (B)**	LYS, ARG, (HIS)
Short-Polar (SP)	GLY, SER, GLN, ALA, (HIS)
Long-Neutral (LN)	MET, VAL, LEU, ISO, PHE

Note: *negatively charged AA side chain at pH 7.4, ** positively charged AA side chain at pH 7.4.
HIS is listed in parentheses due to *apparent* inconsistencies pertaining to its respective designation.

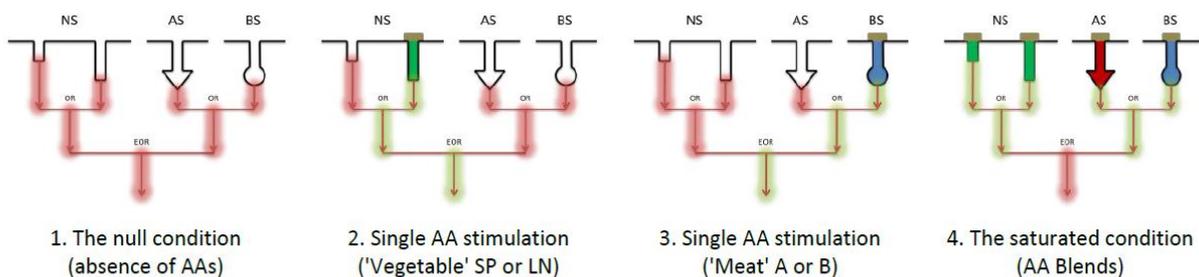
Now, the beauty of the chemosensory cell is that it uses simple voltage differences to communicate either 'on' or 'off' stimulatory states - just like an electronic circuit. Thus, voltages generated within either type of system can be effectively modeled using simple Boolean logic. As introduced above and modeled below, the surface of cilia are envisioned to possess four types of AA binding sites which are, in turn, dedicated to the recognition of either A, B, SP or LN class AAs. This 'receptor site quartet' is 'wired' in such a way so that exposure to members of either one OR both charged (A,B) classes of AAs, *or* constituents from one OR both classes of neutral (SP,LN) AAs, will give rise to a stimulatory response. However, combining a pair of 'on' conditions, emanating from both of these respective OR gates, will result in a metamodulation (cancelation) of the net signal, as dictated by an EOR junction. This OR/EOR circuit, then, accurately models, as is discussed further below, the 'cancelling' properties associated with AA blends and mixtures.



Additionally, our novel 'receptor site quartet' model, when coupled with a statistical analysis of how multiple quartets would respond with regard to a range of AA occupancies (i.e. as associated with various AAs mixtures over a range of ambient concentrations - as experienced by fish in the wild), not only quantitatively describe the results of essentially every academic or other study so far conducted⁴⁻¹⁰, but, most significantly, also allow for the stimulatory properties of virtually any AA combination to be determined*. That's right - no more trial and error! This latter fact is, clearly, of massive significance. Indeed, this new methodology subsequently allowed for the development of Impulse™ - our latest, 3rd generation biostimulant which, as mentioned above, is comprised of a unique AA combination plucked from a possible 38,000 'trial and error' possibilities.

By way of illustrating the utility of the receptor site quartet model, several common conditions of AA stimulus, similar to those actually experienced by fish, are illustrated below. Our first 'null condition' exemplar provides an obvious baseline - the OR/ER circuit returns an 'off' response in the absence of AAs. Our second and third examples show the significant effect of single AA classes on stimulatory

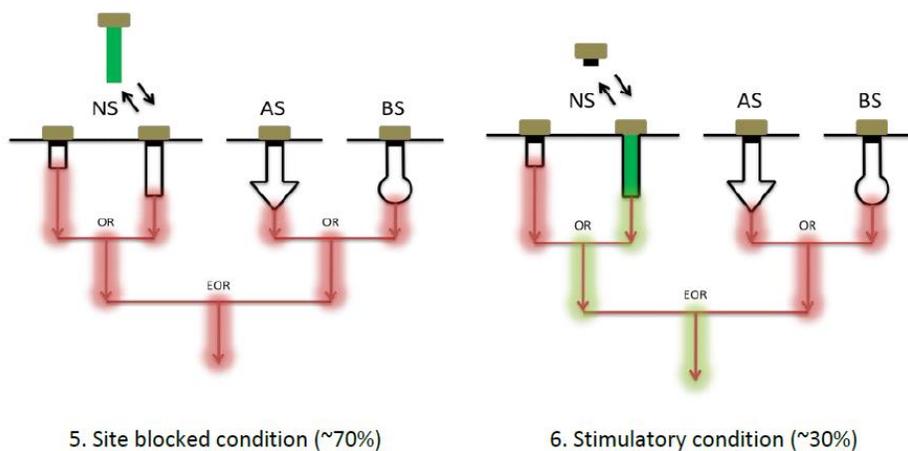
response. In each case an 'on' condition is generated by either uncharged (2.) or charged (3.) AAs by the OR/EOR circuit model (below)- a result confirmed by both experimental and field studies. However, it should be remembered that the fishes olfactory apparatus ('nose', barbels etc.) typically host many thousands of individual cilia which, in turn, also house literally thousands of receptor site groupings, with such individual entities being modeled by our Boolean circuit. Thus, the experimental observation of a 'Goldilocks zone' of flux for single charged (A,B) or uncharged (SP, LN) class AAs, emanating from a bait, is easily rationalized through a more expanded, statistically based, view - too high a concentration of either class of AA will result in overstimulation, as an overwhelming fraction of each cilia's receptors would return a threshold voltage - so overloading the chemosensory cell when combined; while an ambient conc. of any single type of AA that is too low, along with its associated low a site occupancy, would not open the necessary fraction of LGICs required to ultimately achieve a (stimulatory) threshold voltage. Our experimental studies and calculations^{3,13} strongly suggest that an optimal level of stimulation is achieved through attaining an estimated 30 - 40% of total site occupancy for either receptor type in isolation. However, given the massive 'orders of magnitude' differences between the number of available binding sites ($\sim 10^4$) and the potentially overwhelming number of available AA molecules leaching from the bait to engage them ($\sim 10^{21}$ per gram of pure AA), the previously discussed fact that single AA embodiments possess inherently narrow ranges of optimal flux is easily rationalized. To use an analogy, it's bit little like trying to fiddle with your garden hose to make it dispense *exactly* 2.5462309 gallons of water per minute - an extra drop or two per minute on either the high or low side will, literally, ruin the effect. In practical terms, this corresponds to keeping the flux of any single AA, leaching from a bait, to within a tight ± 0.5 mg/min tolerance of the optimal flux rate. Indeed, as mentioned above, Ken Townley in *The Beekay Guide to Carp Baits* confirms that: '(betaine) is one of those products that needs to be used carefully. Put too much in and you'll spoil the effect, but get the level just right and you'll have them *crawling up the rods*'... What's been poorly understood to date is exactly how precise these AA dosages (and generated fluxes) actually have to be - a fact that also explains why 'high betaine' pellets and the like have not lived up to expectations.



For natural and fortified AA blends, the rich 'soup' (profile) of AAs present quickly saturates each of the four types of AA receptor site, as illustrated above by example (4.). As is also illustrated by the above diagram, the OR/EOR circuit such saturated AA coverages yields a completely metamodulated, or 'off', stimulatory response - a fact that helps explain the inherently poor stimulatory properties of such blends. This is physiologically essential 'feedback loop', as it means that when the fish are absolutely 'troughing it' the excess AAs released will not stimulate the fish to eat more, and more, and more...

However, under what we like to call the 'low concentration regime', where the flux of AAs is not sufficient to generate a fully saturated coverage, a small fraction of the remaining quartets will be exclusively engaged by the inherent slight excess of either meat (A,B) or vegetable (SP, LN) AAs that, in turn, head the profiles of these respective food sources (see the table in **How do AA Stimulants Work?** for more details on specific food types). Thus, under such conditions, a very limited number of either type 2.) or type 3) quartets will return a mildly stimulatory response for their respective 'vegetable' or 'meat' type profiles. Indeed, as stated above, 'we can now see why AA blends possess stimulatory properties essentially identical to those of very weak single AA solutions - it's all due to the 'non-cancelling' slight excess of a single AA class within the food's profile'. If there is a take home message here, it would be that the very minor stimulatory 'bump' afforded by such blends only occurs at relatively low concentrations - so, for those wishing to persevere with such substandard alternatives, adding a quick 'squirt' (not a big 'splosh') of CSL, GLM etc. to ones bait is definitely the way to go.

'Designer' AA blends (such as Impulse™) work in a radically dissimilar way to natural AA blends, fortified AA blends, or even single AA stimulants. Simply, these 'next generation' embodiments, unlike their predecessors, are designed to function exclusively within the high concentration regime. This is massively significant, as the inherent limitation of having to generate a very narrow 'Goldilocks zone' of AA flux, necessary to achieve an optimally stimulatory effect for the aforementioned formulations, is now completely bypassed for products like Impulse™. Simply, returning to our previous analogy, there is now no need for your hose to deliver *exactly* 2.5462309 gallons of water per minute - things will work just fine so long as the tap is turned on by at least a quarter turn. How is this possible? Briefly, instead of relying on a specific flux of AAs to generate a stimulatory response, a binary mixture of AAs (one stimulatory, one 'site blocking') of a specific ratio, so long as introduced at equal to or greater than a minimum flux rate, will also activate an optimal *fraction* of dedicated AA receptors. The underlying science behind this groundbreaking discovery is illustrated by the following OR/EOR circuit models:



Simply, at high concentrations / flux rates (when the number of solvated AAs greatly exceeds the number of available binding sites), the 'site blocking' AA will saturate the cilia's receptors *without* initiating a stimulatory response - this condition is demonstrated by circuit 5). However, when a fixed *fraction* of stimulatory AAs are incorporated within the AA mix, as illustrated by a combination of circuits 5) and 6), these AAs will then compete with the 'site blocking' species for their dedicated adsorption sites. Now, due to dynamic exchange between the aqueous and adsorbed phases, the overall degree of stimulatory response generated by the mixture then becomes attenuated, to optimal levels, through utilizing AA combinations of a specific ratio¹. For example, an AA mixture comprised of 'site blocking' and stimulatory AAs in a 7:3 ratio will furnish the required ~30% site occupancy, necessary for optimal stimulation, irrespective of how high the ambient concentration becomes.

*The 'receptor site quartet' model, although a good first approximation of how feeding stimulus is transcribed by the chemoreceptor cells of fish, has been modified to better represent the actual relative distributions of A, B, SP and LN receptors found within the olfactory systems of common fish species^{1,3}. Briefly, an examination of virtually any AA profile quickly reveals that AAs with acidic side chains (ASP, GLU) are often found in far greater amounts than any of the other three companion classes. Thus, so not to overwhelm the fishes' chemoreceptors, it has been proposed that less than ~1% of all cilia's AA binding sites are dedicated to the recognition of A type AAs. This fact, in turn, strongly implies that only B, SP and LN classes of AAs are physiologically significant with regard to AA induced feeding stimulation. Of these three remaining AA classes, it is speculated that the vast majority of popular fish species (carp, bass, etc.) possess elevated numbers of B and LN receptors; with AA titration studies, performed at St. Olaf College¹³, determining the B /LN binding site ratio, for cyprinoid species, to lie in the ~1:2.5 range. Finally, a limited number of dedicated scavenger species (lampreys, bullhead catfish etc.) are 'wired' to preferentially detect SP type AAs (SP AAs are thought to be preferentially generated through the decomposition of both plant and proteins³). Thus, while it is not accurate to say that a particular fish species is *only* stimulated to feed by a single AA type, there *is* some truth to the fact that scavengers are preferentially attracted to SP class AAs, with virtually all other species (including the major sporting and commercial varieties) stimulated to feed by either B or LN class aminos. However, it should also be noted that, as pointed out by Maddocks⁹ and others, that AAs belonging to a particular class also possess a range of stimulatory potencies within their respective class - i.e. a league table of sorts. Thus, the topic of chemosensory stimulation in fishes is clearly more complex than summarized here - the actual report³, from which a select amount of pertinent information was taken and then summarized here, is, to use the vernacular, much more of a 'Chinese phone book'. However, this author is always willing to oblige curious anglers with serious questions on the topic. Thus, interested parties are encouraged to forward any such informational requests via the contact page at www.biosourcebaits.com.

Consequences, Consequences....

Great, you made it! Thanks for hanging in there and reading this thing through. As you've no doubt already figured out, the theories presented here represent a radical departure from the current, largely inaccurate, empirically based interpretations of AA induced feeding stimulation common to the angling trade. I don't know about you, but when I read the 'blurb' plastered on the side of the latest bag of 'amino enhanced' bait or feed I'm pretty sure what's written isn't scientifically accurate and that they're basically just spinning a line in order to shift more product. The good news is these days are about to come to an end! Simply, the theories presented here and elsewhere^{1,3} provide a completely quantitative description of both how why AAs induce an involuntary feeding response in fish. When applied correctly, these groundbreaking principles yield both single and binary AA embodiments (Biosource™ and Impulse™, respectively), which have been shown by independent academic studies, to *at least* double anglers' catch rates.

In more detail, Biosource™ treated products have been engineered to generate a patented¹, optimized flux of stimulatory AAs when used in conjunction with common 'match fishing' style feeds and associated applications - most commonly Biosource™ treated feed and/or expander pellets fished

through a 'toss pot', or Biosource™ dosed groundbait, fished through a method or standard type feeder. In each of these cases, the match fishers ingrained 'little and often' or 'feeding to bites' methodology definitely works in the anglers favor, as the dedicated manufacturing protocols developed for each product, when coupled with these 'normal' feeding patterns, generate the narrow 'Goldilocks zone' of AA flux necessary to invoke an involuntary feeding response. Biosource™ also makes a great additive for 'overdosed' single hook baits, such as popups, as any heavy handedness with regard to their preparation will not translate to a broader 'swim wide' overstimulation. indeed, it is generally accepted that such products actually greatly increase the probability of a pick up². Unfortunately, a variety of common feed applications, such as 'spodding' or 'balling' (which demand that a relatively high volume of bait be introduced to an anglers fishing area all at once) are not well suited to the 'little and often' Biosource™ based treatments just mentioned. However, as discussed at length in the previous section, our Impulse™ formulation has been specifically designed to circumvent this 'overstimulation at higher concentrations' concern. Thus, Impulse™ based embodiments are well suited to virtually any application, including those already mentioned - job done! In practice, because impulse™ is designed to function most effectively within the high concentration regime, bait loadings of approximately twice that of our original Biosource™ are typically required. However, in practice this value rarely exceeds ~5% by weight, even for the most impervious of baits, which is easily 'doable'. The underlying microscopic reasoning behind this, as mentioned above, is straightforward - because the stockpile of available AA molecules housed within a bait are typically on the order of a *million trillion* ($\sim 10^{18}$) times more abundant than their target receptors, it is only necessary to include *very* small gram amounts of pure AAs per kilo of bait or feed. Having stated these facts, an interesting consequence of adding an excess amount of Impulse™ to any feed is that, while remaining optimally stimulatory, this effect is spread over a much broader area.

And finally... The question I've been asking myself ever since starting to put this piece together is "how will people respond to this 'new reality' of AA based stimulation?". Basically, I envision forward thinking anglers accepting the new science, as discussed here, and really capitalizing on it. However, for every enthusiastic trailblazer out there always seems to be a conservative 'stick in the mud' mumbling their disapproval in the background. Now, because the ramifications of these discoveries are so profound, my take on this is simple - tune out the noise, give these new additives go, and then make up your own mind - you will not be disappointed, after all, *'he who dares wins'*...

Patrick Mills, February 2013 (updated November 2020)

Section 3: Biographical Data, Glossary and References

Biographical Data - or 'who are you guys, and how do you know all this stuff!?'



Dr. Patrick Mills

Both Trev and I are Brits who live and work just outside Chicago. We both fished matches regularly in England before coming to the States, with Trev being popularly regarded as a 'venue expert' at the Billhook fishery in Hants. I left the UK many years ago, but was fortunate enough to win the US Open back in 2005.

I'm employed as a Chemistry Professor at Joliet Junior College (JJC). One of the side effects of choosing a career in chemical education is that one starts to see the world in terms of the behavior of atoms and molecules. I know, it's totally 'dorky', but that's the sad reality of being a chemist! Now, combine such a microscopic view with a passion for fishing and you have the tools and desire needed to pursue the 'holy grail' of understanding why fish find certain natural chemical compounds highly attractive³. The BioSource™ and Impulse™ feeding stimulants we have developed are a culmination of nearly 10 years of extensive research in this area – we hope you'll agree that it was well worth the effort.

A full discussion of all things BioSource™ and Impulse™ can be found at the www.biosourcebaits.com website.



Trevor Burgess



Neil Powell

Neil 'Hillbilly' Powell, as well as being regarded as top rate custom pole float manufacturer, was our primary 'under the radar' tester of BioSource™ 'back in the day'. Neil quietly put away a good number of brown envelopes during testing (apologies if you happened to draw next to Neil at the time, as the deck was a somewhat stacked in our man's favor!). All our testers reports, including Neil's, can be viewed at the biosourcebaits.com website. Neil is now the BSB match fishing consultant, and can be contacted directly through his own website (www.hillbillyfloats.co.uk).



Tom Meier

Tom Meier, under the supervision of his research advisor (George Hide), completed his dissertation *The Effect of BioSource Feed Stimulant on the Bite Numbers in a Controlled Fishing Environment* at Sparsholt College, UK in 2011. Tom's thesis was the first to provide independent scientific conformation of *The Biosource Effect*.



Ollie Ricotti

Ollie Ricotti is (was) currently working towards the completion of his research thesis, under the supervision of George Hide, at Sparsholt College. Ollie's work with Jigsaw™ / AminoPlex (an Impulse™ prototype) not only confirmed it to be as stimulatory as our original BioSource™, but also ideal for dedicated 'higher dosage' carp fishing applications.

Glossary: (or a list of sciencey words, from the above document, along with their respective definitions - great for slipping into conversation 'down the pub', or elsewhere...)



Adsorbate - An adsorbate is a object (typically a microscopic one, such as a molecule) that adheres to a surface. A custard pie to the face essentially ends up as an adsorbed object.

Adsorption - The process an object undergoes in order to adhere to a surface.



Attenuate - Essentially means to 'calm' or 'diminish'. As the old Harry Enfield 'Scouser' character should have said, *or not* - 'Are you telling me to attenuate down'....

Elucidate - Simply means to 'figure out'. Usually associated with organic chemical structures and associated reaction pathways.

Empirical - Basically means the commentator is sure about something, but has no real clue why. e.g. 'your assessment of United's chances on Saturday are largely empirical'. Most opinion regarding HNVs and other bait related topics are largely empirical in nature, relying on 'gut feelings' and previous experiences in preference to hard facts and/or scientific proof.

Flux - Simply means 'flow rate'. Example: amino acid flux is typically in the mg per minute range.

Iterative - Basically means 'repeated trial and error'. Example: most bait companies' research is iterative in nature.

Metamodulation - Essentially means 'cancelation'. Variants include metamodulate ('cancel') and metamodulatory ('cancelling'). Example: -2 and +2 metamodulate one another.

Objective - A fact-based interpretation and/or conclusion, a bit like how the BBC is *supposed* to operate.



Qualitative - An often assumptive argument or discussion founded on simple 'yes' or 'no' type analyses. Example: 'Bud light platinum is a good beer' is a qualitative (*and, most would say, inaccurate*) statement. The majority of discussions surrounding AA stimulants have, to date, been largely qualitative in nature.

Quantitative - An argument or discussion backed up by 'hard' numbers or factual evidence. Example: 'the sun will rise at 6:32 am tomorrow' is a quantitative statement derived from an accurate mathematical model. Quantitative findings, such as **The BioSource Interpretation**³, are generally considered to be far more reliable than qualitative ones.

Subjective - An opinion based interpretation and/or conclusion, a bit like how Fox News and MSNBC slant things to fit their point of view...

References

1. Worldwide PCT/ US2009/004390
US Patent US 2010/0034957 A1 and 426/656 (pending)
ER Patent 12/462,159
2. Wacker Bait and Tackle, USA (<http://www.wackerbaits.com>)
Non-USA commercial entities interested in entering into an Impulse™ manufacturing, distribution and/or licensing agreement with BioSource Baits Inc. should contact the company directly via info@biosourcebaits.com.
3. *Chemosensory Stimulation in Fishes: *The Biosource Interpretation*, Patrick Mills, Biosource Baits Inc., December 5th, 2010.
See also "An Angler's Guide to Amino Acids" (YouTube video, <http://youtu.be/dPGy88lPKTc>)
4. Caprio *et. al.*, *J. Gen Physiol.*, 84 (1994), 403 -422
Caprio *et. al.*, United States Patent # 5,171,587
5. Min Xue and Yibo Cui, *Aquaculture*, 198 (2001), 281 – 292
6. Ohno *et. al.*, *Brain Research*, 310 (1984) 13-21
7. Saglio, P., *Journal of Fish Biology*, (1990) 37, 887 – 898
8. Suzuki and Tucker, *Comp. Biochem. Physiol.*, 1971, Vol 40 A, 399 – 404
9. Maddocks, Kevin, *Carp Fever* (10th Ed.), Beekay Publishers, 1988
10. Townley, Kevin, *The Beekay Guide to Carp Baits*, Beekay Publishers, 1998
11. *Meier, Thomas, *The Effect of Biosource Feed Stimulant on the Bite Numbers in a Controlled Fishing Environment*- research dissertation towards fulfillment of Bachelor's Degree of Science in Aquaculture and Fisheries Management, Sparsholt College, UK, 2011
12. See full testimonials and testers' results at www.biosourcebaits.com
13. * Kelly Culhane, Allyson Connor, Marisa Stachowski, Andy Benson, *Amino Acid Stimulation of Fish Feeding Behavior Leads to Possible Metamodulation Affects in the Olfactory Epithelium*, St. Olaf College, MN (unpublished manuscript), 2010.
14. Tim Richardson, *Carp Bait Secrets*, (eBook) and references therein
15. Tim Richardson, private communication
16. Tim Paisley and Friends, *Big Carp* (1990)
Kevin Clifford, *Master Fisherman Carp* (1989)

*These references contain proprietary information and are only available upon request